Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

December, 1918, Issue. In two Sections, of which this is Section two.

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Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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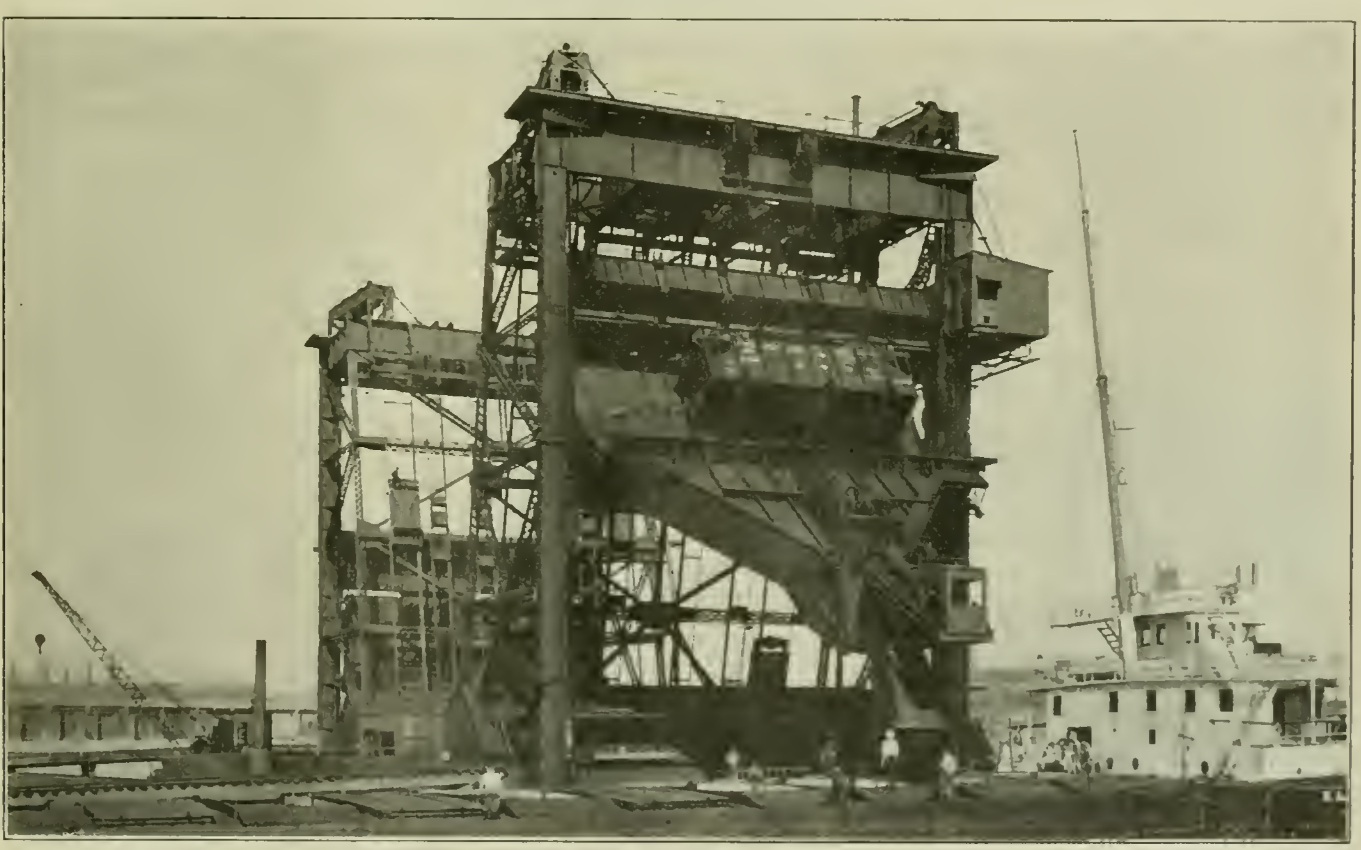
Transferring Coal from Railroad to Vessel

The methods of transferring coal from railroads to vessels, big and little, has, during recent years, undergone some important developments. Special machinery has come more and more into service. And yet, some of the older methods are continued, partly because they are still good methods, and partly because the necessities for a change have not been sufficiently pressing. The mechanical "car dumper" has come into prominent use at many places. Most of these, so far as the United States is concerned, are at railroad terminals on the Great Lakes, particularly on Lake Erie. Car dumpers are also in service at several Atlantic ports. There are a number at New York harbor, several at Hampton Roads and a couple at Baltimore, Md. At Charleston, S. C., the Southern Railway operates a movable car dumper—that is, a dumper which moves on its own track out onto the deck of a large pier.

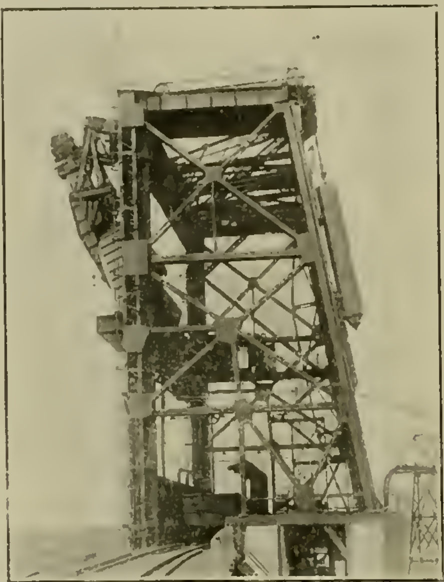
The "moving belt" has also come into service as a means of conveying coal after it leaves the dumper and bringing it out onto the pier and placing it at points from which it may be more readily put into the vessels. Such belts form part of the system in use in Baltimore. At Hampton Roads, the most modern piers are those onto whose decks the coal is brought, not in the cars used to bring the coal from the mines to the seaboard, but in specially made electrical coal cars. They run under their own power from the dumpers to the land-end of the pier, where they are received by elevators which hoist car and coal to the deck 90 ft. above the water. These cars then move along the deck to the desired points. At Charleston, S. C., the railroad car is taken out onto the pier. Sometimes the car dumper is right alongside the water's edge. The loaded car is elevated and dumped, the coal movement being onto an apron and from the apron into a chute and then into the vessel.



HOPPER COAL CAR UP SIDE DOWN ON DUMPER. COAL PASSING THROUGH TELESCOPE CHUTE TO BOAT.

When the cars can be dumped practically at once into the holds of vessels, as just described, the problem of transferring coal from rail to boat is much simplified. Apparently there are no cases as yet where a dumper delivers coal directly to big trans-Atlantic vessels. If these long, wooden piers used at Atlantic ports are tall enough and the water deep enough, the coal may be delivered by chutes to big ocean-going ships. Thus, there are such piers at Philadelphia and Baltimore. The big wooden pier of the B. & O. at Curtis Bay at Baltimore harbor is a notable example of the tall, old-time, wooden pier. The old, low piers may deliver coal to a barge or lighter and the latter make delivery to the vessel. This is the general practice at New York. The ocean liners, as a rule, do not go up alongside coal piers to get their coal, but receive it from harbor boats. This coal is handled at least twice after it leaves the mine—first, when it is delivered from the railroad car to a pocket or bunker on the pier and thence to the harbor boat; second, when it is transferred from this boat to the bunkers of the big ship.

Getting the coal out onto these wooden piers is often a railroad job pure and simple. If the general level of the railroad is high above the water, then it may be possible to have the deck of the pier at about the same height. The cars are pushed out onto the deck by a locomotive to the land-end of the cars have to be brought up a considerable distance. There may be a long gentle up-grade or a short steep one. It may be a question of how much room there is. Generally, empty cars are rolled off the pier by a down-grade leading back to the land-end. The loaded cars are discharged into bins or



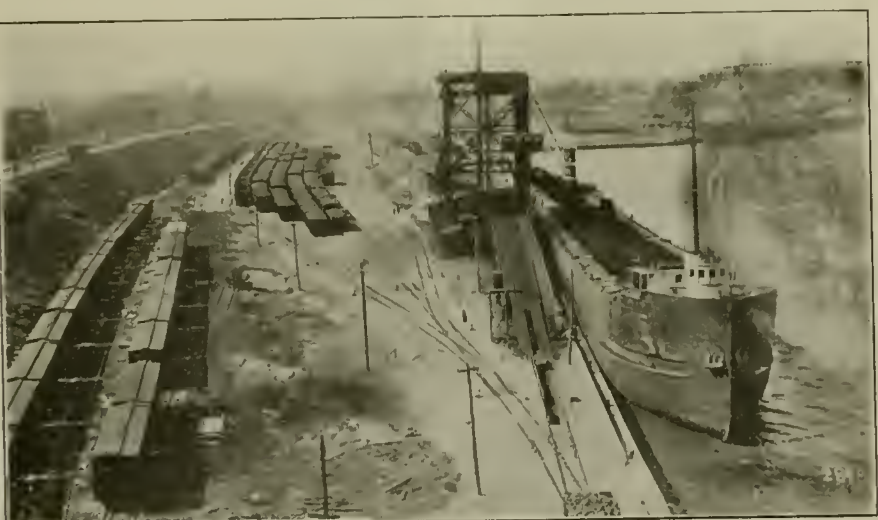
CAR DUMPER AT CONNEAUT, OHIO

pockets beneath the deck. Here the coal is kept until wanted. From the bin, it goes by a chute outwards and downwards into the vessel.

The great height of some of the piers, both wooden and steel, which make to get the proper steep grade. Some of the big vessels are both broad and tall. The top of the hatch will be higher the more nearly empty the ship is. A big vessel may, when empty have a hatch standing 43 ft. out of the water. This is as high as the roof of a three story house. When we consider the necessity of the chute above the hatch and of the pier deck above the bin, such heights as 90 ft. become reasonable. There are two piers of this height in this country. These are the great, modern structures of the C. & O. and the N. & W. railroads at Hampton Roads. The Virginian Railway has a pier in the same harbor about 70 ft in height. Wooden piers of the height needed for the business at the spot are apt to be popular because they are not especially costly to build nor expensive to operate. It is very attractive as a general rule, to railroad managers when it is possible to use ordinary locomotives in getting the loaded cars out onto the pier decks. But questions of space and rapidity of action also have to be considered. It is probably quick action that has impelled the construction of mechanical car dumpers, especially on Lake Erie.

The coal business on the Great Lakes seems to have grown up in consequence of the shipment of grain and ore from ports on Lake Superior to ports on Lake Erie. So coal came to be shipped in quantity and could be sent at a low cost because the ships had to move. These ships could not afford to wait any length of time to get their coal. A long stay in a port at either end of the route made the freight cost increase.

The loaded car is run up-hill to the dumper; then it is lifted to a level previously decided upon; and then it is overturned sideways. The coal tumbles out onto a big apron. This is set to slope downwards. As the coal slides down, the sides of the apron converge and force it into the mouth of a chute. The coal now passes through the chute into the whale-back. When the cradle, as the L-shaped elevator of the dumper is called, returns to its bottom position, another loaded car is ready to come on board. The new car may shove the old one off. The empty car now runs down a short incline to a kick-back. The result is that it is started back in the general direction from which it originally came. The elevator of the dumper runs up and down, up and down, making a round trip in a very short time. It will be understood that the shorter the distance from the bottom position to the dumping position, the greater the number of round-trips that may be made in an hour. In order to get this distance as short as may be, the bottom position is set at a little height above the surroundings. There will be a

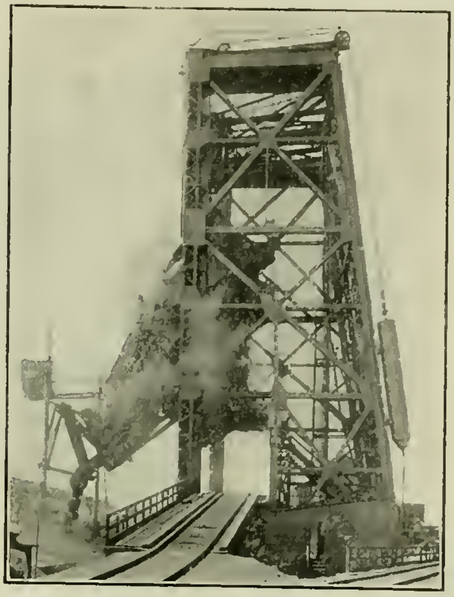


CAR DUMPER LOADING SHIP AT TOLEDO, OHIO. STORAGE YARD TO THE LEFT.

deck. If the deck is absolutely level, then the cars will need to be pushed out. If it has a down-grade towards the sea, then it may be sufficient to get the cars to the beginning of this down-grade. A gentle up-grade towards the sea will require the cars to be pushed all the way. Sometimes the general level of the railroad may be low, so that the delivery in this way is a necessary thing. The bottom of the bin must be high enough above the hatch of the vessel to produce a steep down-grade. It may be necessary that the end of the chute shall be far out from the side of the pier. The further out the end is, the higher the bottom of the bin will have to be above the hatch in order

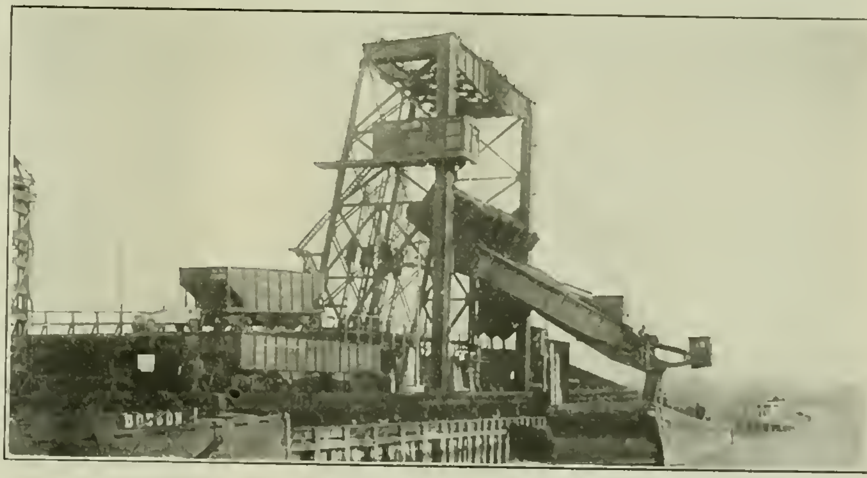
rather sharp incline leading up to the bottom position. The loaded cars are not usually pushed up this incline by means of a locomotive. A special stationary engine, electric or steam, is employed to operate a wire cable. A "mule" or "ground-hog" or "barney" is a small car which, when carried along by the cable, pushes the loaded railroad car up the incline. Gravitation would carry the mule or ground-hog or barney back to the bottom of the incline after it has pushed the new car onto the cradle; but reliance on gravitation alone does not give results quick enough for one or two of the more recent installations. The cable is operated to carry back the mule. The head rope pulls it up; the tail rope pulls it down. The two round-trips, one up and down the incline, the other up and down the dumper tower, are timed to match each other. The loaded car doesn't have to wait: nor the cradle. When the loaded car goes onto the cradle, it finds itself on a short bit of railroad track. This track is not on the floor of the cradle itself, but is on a low platform mounted on rollers or wheels. This platform may be moved directly across the railway track. The cradle, as has already been intimated, is L-shaped. That is, there is a horizontal floor and a vertical wall at one side. When the car is handled the operation is accomplished by lifting this L-shaped cradle. This is carried out by means of one or more hoisting engines hauling in on wire ropes arranged to hoist the cradle and its load. After the hoisting has been going on for a time, the proper level will be reached. At this juncture the cradle will be halted from going any higher. But the pulling on the ropes still continues, with the result that the L-shaped cradle is made to rotate. In fact, the resistance to the further vertical movement of the cradle is on one side only. This is the side where the vertical wall is placed. The arrangements for halting the upward movements are such that the cradle is in effect hinged or pivoted along the region where cradle floor and vertical wall meet. As the cradle turns, the loaded car comes to rest more and more on what was the vertical wall. The weight on what was the floor becomes less and less. When the rotation has continued for 90 degs. the weight will be entirely on the "vertical" wall. Some of the coal will have fallen out by this time, perhaps the most of it. The car will be resting on its side and not on its wheels. Some dumpers of a late style are able to rotate through an angle of 160 degs. This is only a short amount less than a complete overturn: 180 degs. would upset the car completely.

One might expect the car to tumble off, but when the cradle begins to rise gripping irons come into action. Thus, in one device the car as it rises carries up with it cross pieces reaching from one side of the car to the other. These cross-bars come into contact with the top edges of the sides of the car. On



CAR DUMPER IN ACTION.

the side where the vertical wall of the cradle is, these cross-bars or clamps may each have a rod running down through the cradle floor. Suppose that there are four of the cross-bars. Then there will be four wire ropes corresponding to them. These ropes are hoisting ropes and run up in front of



COAL DUMPER WITH GONDOLA READY FOR UNLOADING.

the cradle—that is, on the outside of the vertical wall (or perhaps through it). When the cradle overturns, each of these ropes bears against the cross-bar corresponding to it. A groove is arranged on top of each cross-bar to receive the rope when this occurs. The effect of the ropes bearing against the cross-bars is to keep the latter tight up against the top edges of the car. When the car is almost completely upside down, it rests largely on the cross-bars and the cross-bars rest on the ropes.

It will readily be understood that a car dumper handling large loads must be itself a heavy structure and must have a good solid foundation. Even with the movable dumping apparatus at Charleston, where the loads are probably only of ordinary size, the dumper is a heavy affair. After the car has received its load, it is sent along in the direction of the dumper at the distant terminal. There a man gets on the car while in the loaded yard and stays with it until he gets into the "empty" yard. He is on the car, managing the brakes, when the car is taken in charge by the "ground-hog" and rushed up the sharp incline onto the movable platform on the cradle. He now locks his brakes and gets off. When the cradle comes down again with the empty car he gets on board and controls the car as it runs down to the kick-back and then makes its run to the empty yard on a suitable down-grade.

At Charleston the steel tower rests on wheels and is in reality a kind of traveling gantry, being self-propelled It runs on its own track, which encloses an ordinary railroad track between its rails. This machine moves out on the pier, the vessel to be loaded being alongside, and the gantry takes up a position abreast of the hatchway into which coal is to be dumped. The loaded railroad car from the mine is run out onto the pier to a position on the cradle of the dumper. The delivery when the car is overturned sideways is onto an apron or guide discharging into a hopper. The hopper feeds a big, curious loading arm, which stretches out over the water. This arm is not perfectly straight, but has a slight curvature. Through it a push conveyor operates, pushing the coal along to the outer end over the water. However, the coal does

not simply drop from the end into the vessel. The curved arm has at its end a chute which hangs down into the hold. The coal passes into this device at its upper end and out at the bottom. The long curved arm may be lifted at its outer end or lowered, carrying the loading chute with it. The chute may also be directed to different points in the hold, thus facilitating the distribution of the coal in the vessel's hold. After the region of the ship opposite the dumper is pretty well filled, the dumper may be shifted abreast of another hatchway. Likewise the gantry carrying the curved arm is shifted along to a proper position between dumper and vessel. Both at Charleston and at Baltimore the coal is discharged by a car dumper; so that in this respect the two plants are upon an equality. At Baltimore one object is to serve a foreign trade demanding coal in condition to be fed onto grate bars located 3 ins. apart. It is quite a problem to do all the handling necessary to get bituminous coal out of rhe mine, along the railroad and out onto a pier, and into a vessel's hold without smashing up the lumps a good deal, even though the fall is divided up.

Mallet Locomotives of the Wheeling & Lake Erie

Twenty large 2-6-6-2 type Mallet locomotives have recently been delivered to the Wheeling & Lake Erie Railway by the American Locomotive Company. These engines are being operated on the Toledo division between Huron, Ohio and Brewster, Ohio, a distance of 80 miles. The ruling grade is 0.6 per cent, 5 miles long. One of these new Mallet engines takes 61 loaded cars, making a total of 4,314 tons, over this division at an average speed of 17 miles an hour. This is the daily performance of these engines.

The engines were designed for 22-deg. curves. They have a total weight, engine and tender, of 611,300 lbs., a total weight of engine of 435,000 lbs., and a weight on drivers of 357,500 lbs. The total wheel base of engine and tender is 80 ft. 0½ ins. The total wheel base of the engine is 50 ft. 3 ins., the driving wheel base is 32 ft. 4 ins., and the rigid wheel base is 11 ft. 0 ins. Cylinders 25½ and 39 x 32 in., 63-in. driving wheels, and a boiler pressure of 200 lbs. give a maximum tractive power, working compound, of 80,400 lbs. The compounding is controlled by the Franklin Railway Supply Co.'s Simplex system.

The boiler is of the straight top inverted slope type. At the first course the barrel measures 90 ins. in diameter outside, while the outside diameter of the larger course is 98 ins. The barrel is fitted with 251 tubes, 2¼ ins. in diameter, and 48 flues, 5½ ins. in diameter and 20 ft. long each. A combustion chamber 39 ins. long is included. The firebox is 132 ins. long and 108¼ ins. wide, having a grate area of 99.2 sq. ft., a firebox depth at the front of 83 ins. and at the back of 59 ins. The distance from the top of the grate to the center of lowest tube is 17½ ins. A total heating surface of 4,678 sq. ft. and a superheating surface of 1,450 sq. ft. is thereby obtained.

All the cylinders have piston valves, the low pressure cylinders having a 12-in. double ported valve. The ashpan is arranged for outside hoppers. On the rear section of the frame the usual splice is omitted and the whole section cast in one piece. The tender is arranged suitable for the type C Street Stoker and also so that it can be changed, if desired, with the least possible alterations to suit pulverized fuel. The boiler and machinery were designed for a pressure of 220 lbs. This engine was built at what used to be called the Brooks Locomotive Works at Dunkirk, N. Y. Some of the dimensions, etc., are here appended for reference.

Track gauge, 4 ft. 8½ ins.; fuel, bit. coal; piston, H. P. 25½ ins.

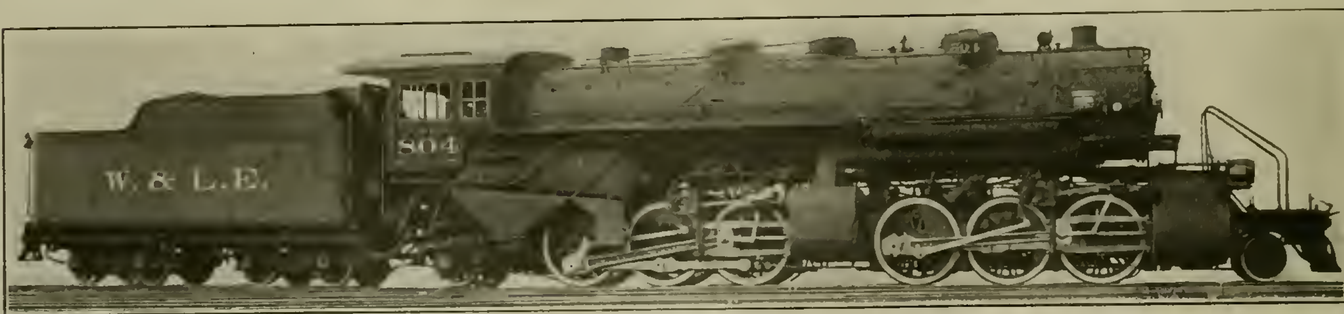
Flues—Material, cold-drawn seamless steel; number, 48; diameter, 5½ ins.

Tubes—Thickness, No. 11, W. G.; flues, No. 9, wire gauge; length, 20 ft. 0 ins.; spacing, 13/16 in.

Heating Surface—Tubes and flues, 4,319 sq. ft.; firebox, 305 sq. ft.; arch tubes, 54 sq. ft.; total, 4,678 sq. ft.; superheater, 1,450 sq. ft.; grate area, 99.2 sq. ft.

Wheels—Driving diam. outside tire, 63 ins.; center diam., 56 ins.; driving material, main, cast steel; others, cast steel; engine truck, diam., 33 ins.; kind, cast steel; trailing truck, diam., 36 ins.; kind, cast steel; tender truck, diam., 33 ins.; kind, cast steel.

Axles—driv. journals main, 10½ x 13 ins.; other, 10½ x 13 ins.; engine truck, journals, 6½ x 12 ins.; trailing truck journals, 8 x 14 ins.; tender journals, 6 x 11 ins.



Geo. Durham, S. M. P. 2-6-6-2 FOR THE W. & L. E. RY. Am. Loco. Co., Builders.

Cylinder—Type, valve; diam. L. P. 39 ins.; stroke, 32 ins.

Tractive—Power, simple; 80,400 lbs. Factor of adhesion, 4.43.

Wheel Base—Driving, 11 ft 0 ins. and total, 50 ft. 3 ins.; engine and tender, 80 ft. 0½ in.

Weight—In working order, 435,000 lbs.; on drivers, 357,500 lbs.; on trailer, 48,500 lbs.; on engine truck, 29,000 lbs.; engine and tender, 611,300 lbs.

Boiler—Type, straight top; O. D. first ring, 90 ins.; working pressure, 200 lbs.

Firebox—Type, wide; length, 132 ins.; width, 108¼ ins.; combustion chamber, with length, 39 ins.; thickness of crown, ⅜ in.; tube, ½ in.; sides, ⅜ in.; back, ⅜ in.; water space front, sides, back, 5 ins.; depth (top of grate to center of lowest tube) 17½ ins.; crown staying, 1 1/6 ins.

Tubes—Material, radial hot-rolled seamless steel; number, 251; diameter, 2¼ ins.

Boxes—Driving, main, cast steel; others, cast steel.

Brake—Driver, American; tender, Westinghouse; pump, 2-11 ins.; reservoir, 1-18½ x 96 ins., 2-18½ x 132 ins.

Engine truck, Economy; trailing, Cole.

Exhaust—Pipe, single; nozzles, 7⅜, 7½, 7⅝ ins.; grate style, rocking.

Piston—Rod diam., 4 ins.; piston packing, snap rings.

Smoke Stack—Diameter, 18 ins.; top above rail, 15 ft. 6 ins.; tender frame, channel.

Tank—Style, water bottom; capacity, 9,000 gallons; fuel capacity, 15 tons.

Valves—Types, 12 ins.; piston travel, H. P., 6½ ins.; steam lap, 1 in.; L. P. travel, 6 ins.; steam lap, 1 1/16 ins.; ex. clearance, H. P., ¼ in.; L. P., 7/16 in.; setting, H. P. ⅛ in.; L. P., 3/16 in.

This engine is a good example of the powerful machines of this type, which are now constantly being built.

Convertible Cars For Rough Freight

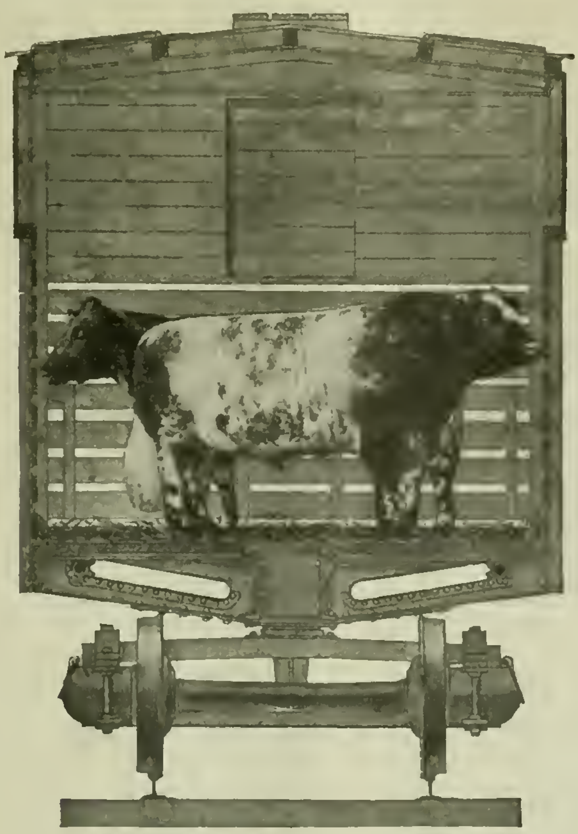
These are the days when there is an alleged shortage of freight cars, and the causes of the so-called shortage are being gradually eliminated. It is quite probable when this is thoroughly done, that it will be found that there are cars enough, but they have not hitherto been handled as they might have been. One of the endeavors to reduce this "shortage" of cars is the introduction of convertible cars. That is a class of car that can carry rough freight and quickly dump it, and on other occasions the same car can transport livestock and other forms of merchandise which must be unloaded rather than dumped, and for which a standard box or gondola with flat, even, floor is the most suitable.

STOCK CAR WITH LEVEL FLOOR, READY FOR CONVERSION.

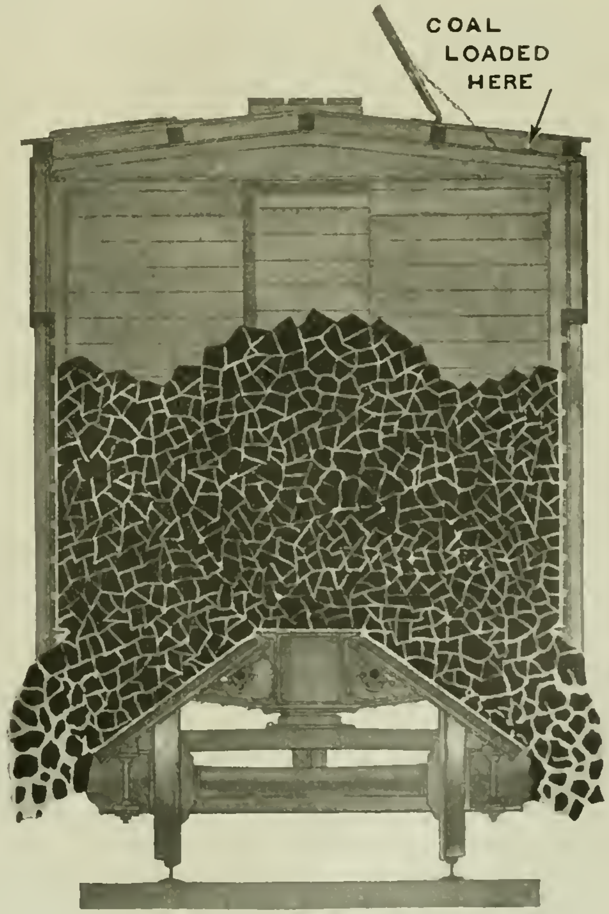
The objects sought by the use of the convertible car are briefly: To provide a flat bottom gondola with removable ends and swinging sides for the movement of earth, ballast and rough freight. To comprise in this car a form of construction making it readily convertible into a hopper car for ballasting track by discharging the ballast between the rails and spreading it over the ties while the train is in motion. To maintain such construction that the cars could be readily converted into standard gondolas for revenue traffic, ore, coal, and other rough freight.

The car already designed has not only capacity and strength to carry fifty-five tons of ballast in the hopper between the trucks, but has also when converted into the gondola form, sufficient capacity to carry fifty-five tons of coal. The drop doors in the floor for discharging the load facilitate very greatly the unloading of coal, and the door in the bottom of the hopper for controlling the discharge of ballast saves all the labor expense of distributing the ballast. Both of these features are combined in one car, making a car having high efficiency for ballasting during the summer months, and for coal handling, and ore carrying, during the winter. The newer type of car is meeting with a measure of favor, and is being purchased by such roads as the Chicago & Northwestern, the Illinois Central and the Denver & Rio Grande, railroads.

Convertible cars are built either of wood, composite material, or all-steel construction, for any gauge of track, and for any capacity from twenty tons up to and including fifty-five tons.



STOCK CONVERTIBLE CAR. ARRANGED FOR CARRIAGE OF ANIMALS.



BOX CAR WITH HOPPER DOORS IN FLOOR, CARRYING ROUGH FREIGHT.

This style of car is only one of the various kinds of general service cars which are built by the different manufacturers, each of whom have a varying

C. B. & Q. GONDOLA SHOWING FLAT FLOOR.

difference in their own special design, but all of which designs follow the same general principal of construction and operation exemplified in our illustrations.

As to the question of general service, box or stock cars, the floor invariably is similar in design, but usually the drop floor doors are of wood on steel frames, with angles which support and stiffen the doors for the various lading and even to the carrying of machinery and pig iron.

The description as revealed in one of the cuts, shows one-half of the car with doors closed, and flush with the top of crosstie diaphragms and under cover plates, which form a lap, and the other two sections, one showing doors entirely removed, and the other showing the doors down in full position, will give a good idea of how the thing is done.

As to the operating of these cars as dump cars, this is done by the manipulation of the levers, pawls and ratchets in place at each corner of the car. They are attached to the locking shaft, which shaft is turned by the lever in a rolling motion, outward to close, and inward to open, the doors always resting on this locking shaft. In this case the levers are outside the end sills, but it is often desirable to put them inside the end sills, and sometimes under the fixed floor near the end sills, in which case lever sockets are provided. With the general service car it is possible for one man to dump the contents in from five to ten minutes.

NORTHERN PACIFIC WITH DUMP DOORS OPEN.

Inspection and Testing of Steam Locomotives and Tenders

It appearing, that the act of March 4, 1915 (Public No. 318, 63d Congress), amending the act of February 17, 1911, making said act apply to and include the entire locomotive and tender and all their parts, requires, among other things, that each carrier subject to said act shall file its rules and instructions for the inspection of locomotives and tenders and appurtenances thereof with the chief inspector within three months after the approval of the act and after hearing and approval by the Interstate Commerce Commission, such rules and instructions, with such modifications as the commission requires, shall become obligatory upon such carrier; Provided, however, That if any carrier subject to said act shall fail to file its rules and instructions, the chief inspector shall prepare rules and instructions not inconsistent therewith, for the inspection of locomotives and tenders, to be observed by such carrier; which rules and instructions being approved by the Interstate Commerce Commission, and a copy thereof being served on the president, general manager, or general superintendent of such carrier, shall be obligatory, and a violation thereof punished as provided in said act.

It further appearing, That a full investigation has been had and that there has been a full hearing and consideration by the commission of evidence, briefs and arguments with respect to the rules numbered 129 and 131 of the rules and instructions for inspection and testing of steam locomotives and tenders, as submitted by the chief inspector and referred to in the order of the commission dated October 11, 1915;

It is ordered, That said rules numbered 129 and 131 of the order of the commission dated October 11, 1915, providing rules and instructions for inspection and testing of steam locomotives and tenders to be observed by each and every common carrier subject to the act of Congress aforesaid as the minimum requirements, shall be as follows:

LIGHTS.

129. *Locomotives used in road service.*—Each locomotive used in road service between sunset and sunrise shall have a headlight which shall afford sufficient illumination to enable a person in the cab of such locomotive who possesses the usual visual capacity required of locomotive enginemen, to see in a clear atmosphere, a dark object as large as a man of average size standing erect at a distance of at least 800 feet ahead, and in front of such headlight; and such headlight must be maintained in good condition.

Each locomotive used in road service, which is regularly required to run backward for any portion of its trip, except to pick up a detached portion of its train, or in making terminal movements, shall have on its rear a headlight which shall meet these several foregoing requirements.

Such headlights shall be provided with a device whereby the light from same may be diminished in yards and at stations or when meeting trains.

When two or more locomotives are used in the same train, the leading locomotive only will be required to display a headlight.

131. *Locomotives used in yard service.*—Each locomotive used in yard service between sunset and sunrise shall have two lights, one located on the front of the locomotive and one on the rear, each of which shall enable a person in the cab of the locomotive under the conditions, including visual capacity, set forth in Rule 129, to see a dark object such as there described for a distance of at least 300 feet ahead and in front of such headlight; and such headlights must be maintained in good condition.

It is further ordered, That the said rules numbered 129 and 131 shall apply to all locomotives constructed after July 1, 1917, and for locomotives constructed prior to that date the changes required by the above rules shall be made the first time locomotives are shopped for general or heavy repairs after July 1, 1917, and all locomotives must be so equipped before July 1, 1920.

By the Commission:

(Seal.) GEORGE B. MCGINTY,
Secretary.

Friction Draw Gear

Effect of Impact on a Standing Car—What Is Capacity of Draw Gear—The Difference in Give Between Wooden and of Steel Cars—Experiments Regarding Centre Line of Buffing and Pulling—The Rivet Shearing Test

At a recent meeting of the Canadian Railway Club, held at Montreal, Que., Prof. L. E. Endsley, professor of engineering in the University of Pittsburgh, Pa., spoke substantially as follows:

Draw gears have been much discussed by the railway people for a great many years, and there are many phases of this subject. The attempt will be made here to give a few points in regard to this matter. There are three things that draw gears may do in the handling of railway cars. These may be divided in general as follows: 1. Produce slack in starting trains. 2. Control slack in the movement of trains. 3. Reduce the impact force in the switching of cars. In all of these the principle involved is the same, namely, producing the same speed in two cars that may be coming together or going apart because of differences of speed. The draw gear to be effective in doing this, must have a capacity that is relative to the difference in speed. A difference in speed of, say, one mile an hour, a draw gear of small capacity will suffice, but if the difference in speed is 4 miles an hour, it will take a much larger draw gear, namely, sixteen times as large to prevent a shock, for the energy of a moving body is proportional to the square of its velocity.

Draw gear capacity is the number of footpounds of work required to just close the gear. That is, it can be represented by an area, as shown in Fig. 1. The lower line of this area in Fig. 1 represents the travel of the draw gear and the upper distance represents the force on the coupler until the gear closes and the horn strikes. This is the force on the draw gear. Now, if we assume a gear with a travel of 2 ins., or from A to C in this figure, a final pressure of 150,000 lbs., or from C to B, and that the pressure necessary to close the gear under discussion was directly proportional to the movement, the line of action of the gear would be a straight line and would be represented by AB. The capacity of the gear then would be represented by area ABC. Now, it will be appreciated that if we wish to increase the capacity without increasing the slope of the line AB, we must increase the travel, and if we should increase the travel to double that shown in the shaded area, we would have 4 times as much capacity as we had before. That is, if AC equal half of AF, the area ABC is one-fourth of AEF. While if we wish to increase the capacity of the gear and not the travel, we will have to increase the slope of line AB to AD, in order to keep this pressure 300,000 lbs. or below, and will only get an area represented by ADC, which is only twice that of ABC. The slope of line AD is much greater than line AB, and should we want to get 4 times as much area as we had in ABC and still have the same travel, we will have to increase the pressure to 600,000 lbs., and then the area of AGC will be 4 times ABC, or area AGC will equal AEF, and the capacity of these two gears will be the same. The 2-in travel gear will have twice the final force that the one with the 4-in. travel will have. This final force is what a great many people have called the capacity of a draw gear. The comparison shown in Fig. 1 is ideal. I think it would be almost

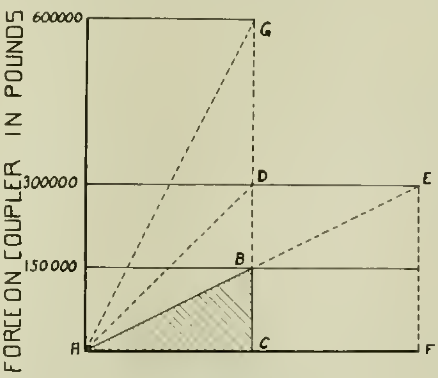


FIG. 1. DIAGRAM OF AREAS.

impossible to construct a draw gear that has a slope equal to line AG. But this figure was merely given to illustrate the advantage of long travel gears.

If we have a draw gear that has a capacity equal to one-fourth the difference of energy of two cars in impact, the cars will not receive a shock above the maximum force necessary to close the gear. That is, if a car is going four miles an hour and strikes a car standing still, it will produce in the standing car approximately half of the speed of the moving car, or, in other words, put into the standing car one-fourth of the energy that was originally in the rolling car. The rolling car will retain approximately one-fourth and coast down with the second car, but half the energy is gone and it must be absorbed in the draw gear or some part of the underframe. Of course, some of this energy may be absorbed, due to the shifting of the load, but it must be destroyed in some manner. If it is not done in the draw gear, it is bound to be done on the underframe or the coupler.

This shifting of the load amounts to a good deal with some kinds of freight, such as coal and ore. Now, if the load should shift one inch, this would be equal to increasing the draw gear travel one inch; also, any give in the underframe would be equal to increasing the travel of the draw gear. There is quite an appreciable difference in the give of cars. Steel cars only give half as much as wooden cars below the elastic limit, assuming that both have the same ultimate strength. This fact is one thing that has been considered in wooden car construction. There has been a very decided give in the bolt holes between the draft timbers and sills. Thus the car itself has been absorbing the shock and there has not been as much need for a draw gear of large capacity. But when using all steel cars with no give in the rivets, the draw gear must do the work of absorbing the difference in energy between the two cars coming together in impact or the coupler or some other part of the car will have to do it; if the coupler is stronger than the other part of the underframe, the underframe will have to do it.

In order to illustrate what energy is necessary to be absorbed for different speeds of cars in switching service, Table No. 1 is given. Column 1 of this table gives the speed in miles an hour; column 2 gives the footpounds of energy in the moving car at the speed given in column 1; column 3 gives the capacity of the draw gear that should be used in each car for the speed represented in column 1 for two cars weighing loaded 150,000 lbs.; column 4 gives the height of drop that the 9,000-lb. hammer should fall before it shears off nine 19/32-in. rivets to have the capacity given in column 3. This column was obtained by multiplying the values in column 3 by 12 and dividing by 9,000 and adding 3. The first part of this deduction is to obtain the height of drop to close the gear. The 3 added at the end is the added height in inches which it will take to shear off the rivets after the full capacity of the draw gear has been taken up.

It will be seen that a very small capacity is necessary for one mile an hour, namely, a drop of 4.7 ins. of the hammer, but a gear that is many times as large is required for a difference in speed of 6 miles an hour, or 63.0 ins. This height should be the total fall of the hammer to just touch the dummy coupler used, plus the travel of the draw gear. That is, if the fall of the hammer was 15 ins. before it

started to close the gear and the travel of the gear was 3 ins., the total capacity of the gear would be represented by 18 ins. Personally, I think that we should take care of 4 miles an hour switching speed in the draw gear design. It we should do this, that is, if the draw gear would just close under a speed of 4 miles an hour and never close under a speed of less than that, it is certain that the coupler or any part of the car would never be damaged in an impact between two cars at a speed of 4 miles an hour. There is not a coupler on the market but that will stand a greater impact force than the force necessary to close any draw gear on the market today. I have given some heights of drop that a 9,000-lb. hammer should fall before it shears off one or both lugs with nine rivets 19/32 ins. in diameter. This method of testing draw gears was first used, I think, in September, 1908, by the Westinghouse Airbrake Company, but there 9/16-in. rivets were used. To my mind, this is the best method of determining the capacity of a draw gear. In this method of testing, the gear is mounted on two lugs that are riveted to two short pieces of channels and held upright between posts. Each lug has nine rivets, each 19/32 ins. in diameter, each lug carries half of the load, and the test is made by dropping the 9,000-lb. hammer from 1 in., 2 ins., 3 ins. and so on, until one lug is sheared off. This shearing of these rivets occurs at a pressure of about 275,000 lbs., for that is the average that I obtained on several sets of lugs.

TABLE NO. I.

Comparison of a car, total weight 150,000 *pounds.*

Speed in miles per hour.	Approximate energy in footpounds.	Capacity of gear in foot-pounds to just close.	Approximate height of drop of 9,000 hammer to shear nine 19/32 rivets.
1	5,000	1,250	4.7 inches
2	20,000	5,000	9.7 inches
3	45,000	11,250	18.0 inches
4	80,000	20,000	28.7 inches
5	125,000	31,250	44.7 inches
6	180,000	45,000	63.0 inches

When the 9,000-lb. hammer drops vertically on a draw gear that is supported on these two lugs that rest on a solid base with these same rivets in the lugs, they will not shear off until an approximate pressure of 275,000 lbs. is reached, and in a good many tests with the same draw gear and different sets of lugs, the variation is never more than 1 in.

In the paper, I have talked about draw gear capacity but have not mentioned the absorbing capacity. I wish to distinguish between these two. I defined draw gear capacity as the footpounds of work necessary to close the gear. The absorbing capacity is that which is not given back when the draw gear is released after being closed. This feature of a draw gear can be very easily obtained from the drop of the 9,000-lb. hammer by putting a recording pencil on the hammer and causing it to mark on a revolving drum. If the hammer falls 20 ins. and rebounds say 10 ins., it is evident that the absorption has been half the capacity. This feature of the draw gear comes into play in the controlling of the slack of a long train in going up and down grades and in the starting and stopping of trains. We can not expect a draw gear to last the life of the car any more than we can expect a brake-shoe to last the life of the car. They both are put on a car for a somewhat similar purpose, namely, to stop the

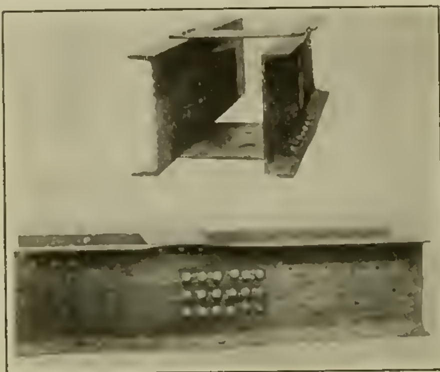


FIG. 2. DEFORMATION OF SILLS ON CENTRE LINE OF DRAFT.

car, and if we expect to get any value from our brake shoes, we must expect wear.

A thing which may be of interest is the results of some tests which I have just made in regard to the center line of draft. Some time ago the committee on car construction made some recommendations with regard to the center line of draft,

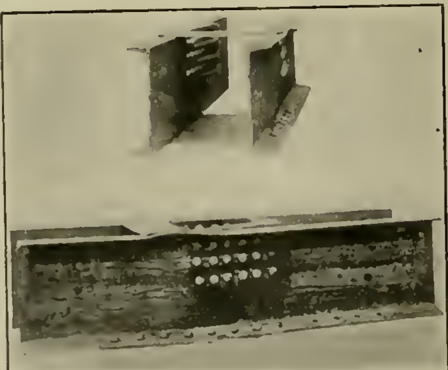


FIG. 3. DEFORMATION OF SILLS, CENTRE LINE OF DRAFT, 3¾ INCHES BELOW.

These recommendations when applied to most cars fixed the center line of draft within 2 or 3 ins. of the center of the sill. In order to get some information on this subject six sets of channels were made up, Figs. 2 and 3. The channels were each 15 ins. high and weighed 40 lbs. per foot. The center line of draft of one set was placed on the center of the channel of 7½ ins. from the edge and this distance from the edge decreased by 1¼ ins. until 2½ ins. was obtained. Two sets of channels with the center line of draft 6¼ ins. from the edge, were made, one set of which did not have any tie plate. The results obtained are given in Table No. 11 It is evident from this table that the center line, the center of the channel of 7½ ins. from the edge and this distance from the edge decreased by 1¼ ins. until 2½ ins. was obtained. Two sets of channels with the center line of draft, 6¼ ins. from the edge, were made, one set of which did not have any tie plate. The results obtained are given in Table No. II It is evident from this table that the center line of draft should be for maximum strength within 2 ins. of the center line of the sills, and that the tie plates are of great value in strengthening the sills. By looking at Fig. 2 it will be seen that when the line of draft is on the center, both upper and lower flanges are bending, while with the line of draft 3¾ ins. from the edge, as shown in Fig. 3, nearly all of the bending is at a place in the edge of the channel closest to the line of draft. This is nothing extraordinary, for if you eccentrically load any two pieces of steel, the one close to the load is going to take most of the work and the ultimate strength of the system is reduced.

Maximum pressure obtained in impact test made on 15-in., 40-lb. channel with 15,000-lb. pendulum hammer with different center line of draft:

TABLE NO. II.

Distance from edge of channel	Maximum pressure obtained before the channel failed.
7½ ins.	1,155,000 lbs.
6¼ "	1,125,000 "
5 "	960,000 "
3¾ "	723,000 "
2½ "	662,000 "
6¼ " without tie plate	744,000 "

I have attempted to bring to your minds two or three very importan things in the selection of draw gears and the design of freight cars. One of the most important things is, we will have to increase the travel of the draw gear above that which was thought sufficient some years ago. Some years ago it was felt that 2 or 2¼ ins. was as much travel as should be. But I am ready today to say that we should have at least 4 ins. of travel, or possibly more, in any draw gear. It is evident from the first of my paper that this arrangement is going to allow us to materially increase the capacity of the draw gear when we design it under 4 or more inch travel.

Another thing that is of importance to railway men is, how are they going to know what capacity of draw gear they are getting. I am confident that the best method for them to use is the rivet-shearing test, as already described. Whether

it be nine rivets 9/16, ten rivets of 9/16, or any other number of rivets does not enter into the subject. What they should have is a set of lugs that will shear just above the force which is necessary to close the gear under test. I can conceive how a gear can be designed for a final pressure of 350,000 lbs., then a test of rivets shearing off at 275,000 lbs. would not be fair. But in any design of a lug, the lug should be made much stronger than the rivets in order that the lugs will not bend down and the gear show a false capacity. I can see how a lug may be built and give false capacity of draw gear, but the lugs should be designed stronger than the rivets.

One thing that is important in the design of a freight car is that the underframe of the car should be made stronger than the coupler. In the past it has been the coupler that has been saving the car after the draw gear went solid. You men who repair cars appreciate the large number of couplers that fail. If we move the center line of draft out from the center of the sills or leave off the tie plate, then the pressure of only 662,000 lbs. destroys the sills with the center line of draft 2½ ins. from the edge of channel. The new coupler will stand this and more in compression, which means that it will not be the coupler but the underframe, and if the underframe it will cost considerably more to replace than the coupler. I assume that everybody here knows that a friction draw gear is superior to a spring gear, but I do not believe that all of you know how much this difference is. The highest capacity spring gear in use, made of two M. C. B. Class G springs, will fully protect the 100,000-lb. car and lading at a switching speed of a little less than two miles an hour.

There are friction draw gears in general use on thousands of cars that will protect the same car and the lading at 4.5 miles an hour. Also, there are many gears on the market that will fall between these two extremes, and each of these gears has a definite speed at which it will protect the car. But if you should attempt to switch the cars at 4 miles an hour while equipped with a spring form of draw gear that only protects the car at less than 2 miles an hour, the coupler, underframe and load are bound to suffer. Either the coupler or the underframe will fail if this speed of switching is kept up. While, should this same car be equipped with the highest capacity gear, it could be switched at 4 miles an hour without any damage to underframe or coupler.

Unless we put a draw gear of sufficient capacity to keep it from going solid, the force is going to the strength of the weakest part. If this is the coupler it will be from 400,000 to 700,000 lbs. on most couplers in service, or if the car be equipped with the new M. C. B. coupler type D, this force will be from 600,000 to 1,000,000 lbs. If it be the underframe that is weakest, and this may occur if the design is not correct, this pressure will be a little less than that given above for the strength of the coupler. But in any case, this force may be 600,000 lbs. Now, if the impact force and shock is 600,000 lbs. and the weight of the car 150,000 lbs., the end pressure per pound of car weight and load will be 4 lbs. per pound of weight, or will be equivalent to standing a car on end that has 4 times as much load in it as the car in question contained. This is what has been knocking out ends of cars, damaging roofs, side walls, and racking the car in general because of insufficient draw gear protection. Now, if the travel and capacity of the draw gear is enough to keep this end force down to 300,000 lbs., the force per pound of weight on the car and load will only be 2 lbs., which would result in practically no damage to the car.

I wish to say that more care must be given the draw gear in the manner of inspection and repairs in order that it may do the work which it was put on for, and which it will do if kept in repair. It may mean new gears or parts of gears, and there will be some expense attached to this inspection and upkeep, but the saving in repairs to other parts of the car is bound to more than make up for this expense.

Saving Freight Cars.

There has for a long time been an annual cry of car shortage, and most people have construed this to mean that there was not enough cars in the country to handle the traffic offered. The German war has shown us that this alleged car shortage was more imaginary than real. Good loading has greatly increased the number of available cars.

On 77 of the principal railroads of the United States, a saving of 114,109 cars was effected in one month of this year solely by increasing the average loading of "less than carload" freight. The reports on which these figures are based, the latest that have been compiled, cover the month of July of 1917, and also July, 1916. They show that the average loading for that class of freight during July of that year was 13,927 lbs., as compared with an average of 11,619 lbs. during the same month the previous year. The 77 railroads from which reports have been received were able to move the total volume of less than carload freight last July in 579,180 cars. Had the average loading for each car been at the same rate as during July, 1916, the railroads would have been compelled to use 693,289 cars.

In addition to increasing transportation efficiency through this form of intensive loading, the railroads are also waging a vigorous campaign to reduce the number of cars and locomotives under repair in their own shops.

The July, 1917, reports show the average number of freight locomotives in the shop or awaiting repairs was 4,122 against 4,460 in the same month the previous year, a decrease of 7.6 per cent. Freight cars under repair in July numbered 135,831, which was 8,647 less than in July, 1916, a decrease of 6 per cent.

Reports to the American Railway Association from all the railroads of the country show that on November the first of last year the excess of unfilled car orders amounted to 140,012 cars, an increase of 25,104 cars over the same day in 1916. Of this number, 97,000 cars are called for in other parts of the country than the congested region east of Chicago and North of the Potomac River where the abnormal war business is heaviest. Many of these orders for cars could be filled if the cars now delayed in the congested regions could be released. The Railroads' War Board is now applying remedies in the endeavor to accomplish this much needed work of reform, brought to our very doors by the German war now raging.

Influence of Environment.

Very few of us understand how great an influence "our environment" and all that the word implies, plays in our lives. The general idea of men who are too busy or too careless to bestow much thought upon the matter is, that from the time they reached man's estate they have molded their own lives; that they have adopted such and such a business, have chosen from all the world the woman who is to be their lifelong companion, have selected their particular friends, and, in short, have ordered their whole career, and this is the reason we so often hear of "self-made men." It is rather remarkable that it is only when a man rises from obscurity to some high position, or from poverty to affluence, that he likes to employ the term, or to hear it coupled with his name. Let his course have been in the contrary direction, and he at once disclaims having had any hand in the matter; then his own will was nothing; hereditary, evil influences, bad luck, everything was against him; but even as he speaks, he is only half convinced of the truth of his excuses. His conscience, if he has one still, whispers to him that he might have done better if he had tried earnestly.

But while courage and energy and perseverence are undoubtedly large factors in a man's success, they do not assure it. Many a man possesses all these, and yet his career proves a failure, because his environment has been such as to neutralize them and defeat all his efforts to get on in life.

Locomotive Headlights

Peculiarities of the Parabolic Curve Made Use Of—The Electric Headlight—How Case and Reflector Serve Their Purpose—Mathematics and Practical Ideas Are Involved

A locomotive headlight is a very necessary thing on an engine running on a modern crowded railroad, yet few who are guided or warned by its light ever consider the study and the knowledge of higher mathematics which are involved in the design of a good headlight. Take for example the case and the reflector made by a good reliable firm such as the Glazier Manufacturing Co., of Rochester, N. Y., and think what its production involves, when lit by the glow of an incandescent bulb, with electrical power behind it, how close to what we are apt to call perfection, it is.

The case is well made of sheet steel enameled white inside. It has no smoke vent, for with the electric lamp it does not need one, but there is an ample ventilator on top, which stands in place of the small smoke vent of the oil lamp, and with its air ingress openings below, and its ventilator top, provides for the free circulation of cool air through the case, all the time, and this is a satisfactory condition. The ground glass plates for the train number, at each side of the case, are lit up brightly by a small incandescent bulb of any candle-power the purchaser chooses to use, and the white enamel in the case helps the diffused light inside the case to illuminate the number plates. Any railway using electrical car lighting, may be able to use up old bulbs grown too dark for passenger car illumination, by applying them in the inside of its headlights to illuminate the case and thus efficiently do a necessary piece of work at low cost.

The actual reflector, made very accurately and carefully of spun copper, is not cut in order to illuminate the number plates. The reflector has only one small hole on the axis at the back and that is just the size of the screw-neck of an ordinary electric bulb. Back of the reflector is the socket for the bulb held in place by an adjustable stand, with grip-nuts, so that the flament of the bulb may be approximately placed in the focus of the reflector, and when so placed and clamped by the gripnuts, the essential position of the bulb is maintained, without the least tendency for the holder to work loose or shift, and this is a condition which is one that requires to be most rigidly adhered to, or the headlight loses its maximum efficiency at once.

There is now on the market a form of concentrated bulb, where the filament is wound in a close spiral, which brings the light close to the focus.

Not only is the unbroken reflector made of substantial copper plate, but the inside surface is silvered heavily, and in no case is the silver replaced or altered to nickel. Actual copper and silver are the two substances used.

When we referred to the accurate spinning of the copper, we mean what we say, for the standard of accuracy is not set by man, nor determined by financial considerations. It is the cold, clear-cut requirements of the science of mathematics which must be satisfied to the last turn, or the product is inferior.

The mathematical curve to which the reflector must exactly conform is one of a most interesting family of curves called the "conic sections." The study of these curves is not new, they are traced out in cutting a right circular cone and each has distinguishing characteristics which form for each its own peculiar properties. The first is the circle, made by cutting a cone across at right angles to its vertical axis or in other words to saw it straight across parallel to its horizontal base. The curve so cut out is a circle. If this sawing across was not exactly parallel to the base of the cone, an elipse would result. If the cone were sawed through on a plane parallel to one of its sloping edges, a parabola would be produced, and that is the curve we are interested in, when considering the locomotive reflector. If, however, the plane cutting the cone be parallel to the axis of the cone or perpendicular to the base, we would have an hyperbola. These four curves are of one family, and shade imperceptibly into one another as the cutting plane moves from the position of parallel to the horizontal base to the position of vertical, or at right angles to the base of the cone.

When we come to treat these sections of the cone as mathematical curves, we discover certain distinguishing characteristics or properties, all different, which each particular curve possesses. Among others, the one which makes the parabola of particular interest to us as the best form for a locomotive headlight reflector is that when a light is set in the focus of this curve, all the rays of light which do not pass out of the aperture in the front, are caught on the smooth, silver surface of the parabolic reflector, and pass out of the aperture as a beam of light parallel to the axis of the reflector. We have, therefore, the small quantity of divergent direct light from the source of illumination, and the greater bulk of reflected light, each ray of which passes out parallel to the axis of the reflector and parallel to each other. Now why this is so, is the property peculiar to the parabola. None of the other conic section curves give it, and a small deviation from this exact form vitiates the result. It is therefore easy to see why the correct manufacture of the reflector is a matter of importance. The complying with conditions is not simply in order to satisfy some man. It is the essential, or the correct reflection will not take place. You cannot talk a wrongly made reflector into giving good results and you can't bribe a mathematical curve nor frighten it into going against its nature.

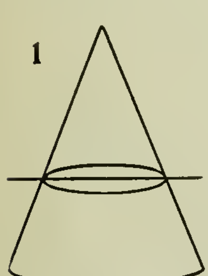
The parabola has been defined by mathematicians as a curve which is equally distant from a fixed point called the focus, and from a fixed line called the directrix. The theorem drawn from this is that the normal, or the line drawn at right angles to the tangent at any point, bisects the angle enclosed between two lines, one of which is that parallel to the axis, and the other is that from the focus to the point on the curve. This really amounts to saying that at any point, taken where you may choose on the curve, the tangent to the curve at the casually selected point is infinitely short; and the equal cutting of the angle by the normal, shows that the angle is such as to deflect the incident ray of light from the focus, and project it along the line parallel to the axis of the reflector. The bi-section of the angle by the normal, makes the angle of incidence equal to the angle of reflection which is in accordance with one of the primary laws of optics.

This infinitely short array of tangents, as we are conceiving them in the mind, may be considered as coming together so closely as to form, not so much a close series of definite tangents each with a minute angle between, but really so near each other are they, that though they perform the function of light reflection, they yet blend or shade into each other so intimately, and so imperceptibly, as to form one continuous curve, and this curved line is without a break or an angle, and is in fact, the parabola with its many wonderful properties. In this fact lies the reason why the parabola is able to throw all its reflected light out of the aperture, as a parallel beam of white light.

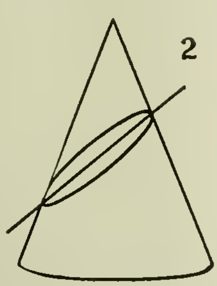
The parabola is a plain curve, and can be laid out on a drawing board in an office. In order to produce the actual reflector for a headlight, the parabola must be revolved about its axis, and the cavernous, deep, silvered reflector is then correctly spoken of as a paraboloid of revolution. The practical proof of this is to take a locomotive with lamp lit and move it up close to the roundhouse door and on the door will be seen two concentric circular areas of light. The larger and fainter of

the two will be the direct light, just as if a candle of high power was placed so that the light passed through an aperture in a divergent beam from the head lamp. The smaller area of brighter light is only slightly larger than the ring of the aperture and it is the reflected light. By placing the engine as described, any one interested will have the apparent "mystery" of the parabolic reflector explained at a glance.

We referred just now to the brighter area of reflected light being slightly larger than the ring of the aperture. So it is, and this is because of the physical impossibility of bringing down the source of light to a mathematical point. There must be a compromise somewhere, because we cannot have an intense source of bright, white light, the size of a pin's head. Theoretically that is what we want for absolute perfection, but so far, it has not been available. It may be that in the future some supply firm, or other agency, will bring out an electrical bulb in which the filament may be run out on two "wires" and then coiled or zigzagged so as to put the mass of the illuminant close together in about the size of a thimble, and so get closer into the focus than at present. Up to the present time, such a bulb has not been developed. Now it is necessary to compromise, and this necessity is the cause of the slightly divergent reflected beam of light. Incandescent bulbs are what they are for good and sufficient reasons. The reflector is what it is owing to the conditions it has to meet. If a compromise has to be made—and here it must be made. It is better to deviate; slightly though it be; from the theoretical focal position of the light, than to sacri-



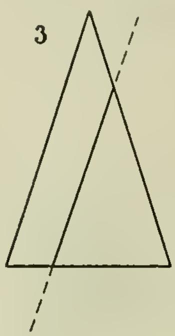
1. CIRCLE.



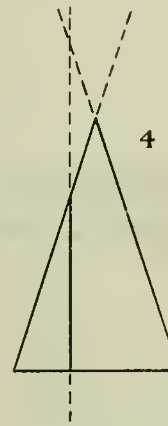
2. ELIPSE.

fice what we call perfection, where we can attain to it. We attain practical perfection in the manufacture of the reflector by making it of readily spun copper, and coating it with a heavy, smooth layer of what is, perhaps, the best reflecting substance known, that is silver. Such then is the Glazier headlight, reflector, case, bulb or oil light and the mathematical beauties of this wonderful curve is what it all is dependent on.

In our illustration, Fig. 5, which is a meridian section of a parabola, the line F P, drawn from the focus F, to any point P, on the curve, is always equal to the line P D, drawn from the point P, on the curve to the directrix. The tangent T A, at the point P, with its normal P N, bisects the angle F P R, and the angle F P N is the angle of incidence, and the angle N P R is the angle of reflection. At P (anywhere on the curve) the point P is, as it were, an infinitely short tangent; but instead of the parabola being a series of short separate tangents, they merge into



3. PARABOLA.



4. HYPERBOLA.

a curved line with the various properties we have described, and these peculiarities and properties and mathematical laws, give to the parabola, when properly drawn, its unique value for a headlight reflector.

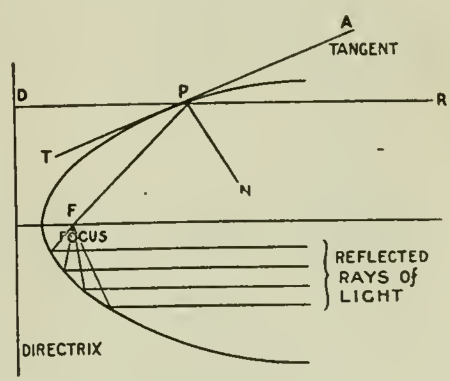
We do not have to offer apologies for touching on the mathematical characteristics of the curve, though we have refrained from introducing formulas or arithmetical calculations. If the workmen who make the reflectors do not know these facts, someone else does know them, or the original pattern could not have been made. The fact that it has been made, and is strictly adhered to, speaks well for the manufacturers, and the fact that they have put durability before cheapness is one of the favorable characteristics by which they are known. Their idea is good quality and a good, serviceable headlight which will stand the rough usage of railway life and will last a long time. This makes economy stand out prominently.

One need not discant on the other and singular properties of this family of conic curves. It may be mentioned as a matter of interest, if nothing more, however, that one of the derivatives of our conic section curves is extremely useful to man. If the focal point of each of these curves be taken as an axle, and the curve rolled along a flat level surface, the axle so made would trace out a line on an upright wall, which would be exceedingly interesting. The focus of a circle is the centre, and an axle through that point, with circle rolled along as a wheel, the end of the axle would scrape or scratch a straight line on the neighboring upright wall. If an elipse was so treated the line scratched on the wall would be a curve called by mathematicians, an unduloid. The hyperbola would give a nodoid, and our headlight parabola would trace out a catenoid. This new derived family of curves are called the roulettes of the conic sections. Among these the catenary curve is the one derived from the parabola and is the one as its Latin name implies, that a chain or rope assumes, when of equal diameter throughout, and hanging freely suspended from each end.

This is the curve used for the cables of a suspension bridge. They assume this form naturally when free or equally loaded on its entire length like the Brooklyn, N. Y., bridge. It is in frequent use in engineering works and its wonderful relation to the first of the open curves of the conic sections makes it unique. Some of the comets which have visited our solar system and which will never return, have been proved by astronomers to have traveled to us, in their mysterious flight, on parabolic curves. The path of a heavy projectile hurled from a powerful gun, is a parabola, modified by friction through the air; and the course of a baseball deftly thrown from the arm of an expert "twirler," follows the gentle modified curve of the parabolic arc, like the death-dealing shell from the gun.

Safety First.

"Safety First" is the foremost thought of an efficient workman. His skill, knowledge and experience must be exercised at



RIGHT SECTION OF PARABOLA SHOWING REFLECTION OF LIGHT.
FIG. 5.

all times in the correct handling of tools and in the use of the proper safeguards.

A capable man always protects himself and the company and prevents needless suffering by obeying simple rules.

Brains will do more to prevent accidents than all the safety devices in the factory. It pays to think.

Reckless, careless, thoughtless workmen endanger themselves, their fellow-workmen, and oftentimes cause hundreds of dollars damage.

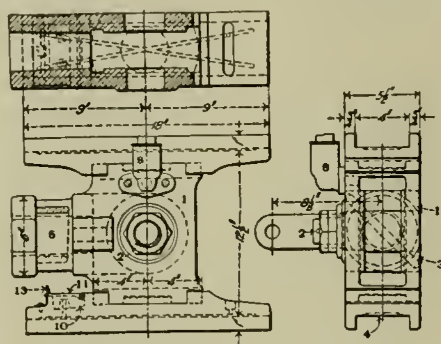
The good man, the trusted man, the go-ahead man is the "Safety-First" man.

Adjusting the Guides and Crossheads

If it is easier to keep well than make well, it is also easier to construct well than to patch up afterward. These two-edged remarks apply particularly to the proper adjustment of guides and crossheads on the locomotive. It goes without saying that they should not only be set perfectly true with the center of the cylinder, but it is equally important that as near an approach as possible to accuracy should be maintained during the time that the locomotive is in service. The action of the main crank on locomotives that are generally run in one direction only is to create an unequal amount of wear on the guides and crossheads, and apart from the inevitable rapid increase of lost motion there arises a distortion in the alignment that cannot be rectified by a mere haphazard removal or introduction of thin liners between the guides and guide blocks.

The perfectly parallel adjustment of the bearings of the crosshead to the direct path of the piston is usually provided for by attaching the piston to the crosshead and having the crosshead bearings planed in perfect alignment with the piston rod. This insures a full bearing of the entire surface of the crosshead bearings—that is if the guides are properly adjusted. On the other hand, if the crosshead bearings are not in the same plane with the piston rod, no amount of tinkering with guide blocks or liners can remedy the defect.

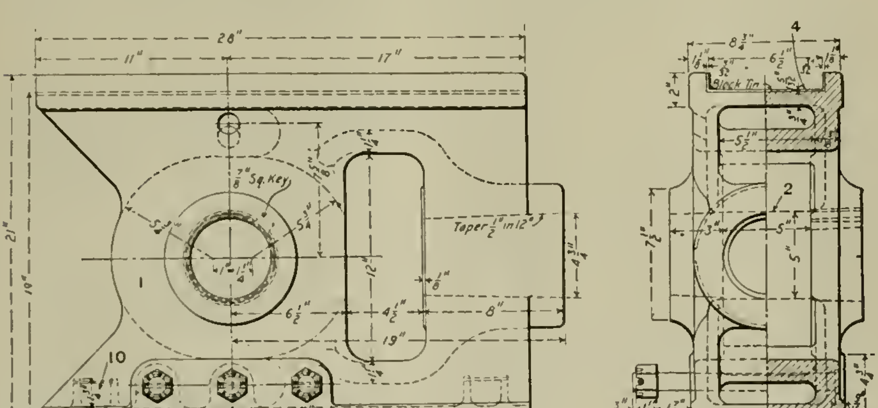
Assuming that the piston rod and crosshead bearings are straight and that the piston has been removed from the crosshead, the operation of lining the guides in place may be proceeded with by first ascertaining the exact center of the hole in the crosshead into which the piston rod has been fitted. This may be readily done by fitting a piece of wood into the hole and attaching a piece of tin or copper to the wood and with a pair of calipers mark the exact center, when found, with a fine center punch. Supposing the crosshead to be of the alligator variety, adapted to run on two-bar guides, the distance from the bottom bearing of the crosshead to the center punch mark may be obtained by extending a parallel strip, or straight edge, along the bearing and carefully measuring the distance at a right angle from the straight edge to the center mark. It should not be assumed that the figures shown on some drawing of that particular class of engine are always exactly duplicated in the work, even admitting that the



ALLIGATOR CROSSHEAD.

work may have passed through the hands of the most skilled mechanics. Perfection in mechanism, as in art, eludes and ever will elude the seeker after the ideal. Hence the necessity for repeating our measurements as we proceed from point to point.

Some mechanics use a guide gauge, consisting of an adjustable needle slidably engaged on a graduated scale, the lower end of which may be held on the straight edge while the needle is adjusted to the center mark. Having obtained the exact distance, a fine line or wire should be stretched through the cylinder and fastened at some movable point beyond the guides. This line should be set by the counterbore in the cylinder. If the counterbore in the back of the cylinder cannot be conveniently reached and the line clearly seen, the line may be adjusted by the stuffing box. In any event it should be borne in mind that on the careful and exact adjustment of this line along the center of the cylinder the complete success of the operation entirely depends.



ONE PIECE ALLIGATOR CROSSHEAD.

The lower guide bar may now be clamped in place, and the guide gauge or scale will readily show its location in relation to the center line. While adjusting the guide bar longitudinally to its true position by liners or otherwise, it should be noted that it is perfectly level crosswise. A straight edge laid across the frames will furnish a suitable basis for levelling. It need hardly be said that it would be poor practice to set the guide bar exactly level while the frames might be showing some variation. The guide bar should correspond transversely, and, except in the case of inclined cylinders, longitudinally with the frames.

It will be borne in mind that in adjusting the bearings of guides and crosshead, almost all kinds of crossheads are furnished with gibs. These form a part of the complete crosshead and should be securely clamped in place while taking the measurement to or from the center, and with guide blocks already in place it may be found advantageous to place a liner of tin or other metal between the gib and body of the crosshead. In some railway repair shops a standard size of crosshead gib is maintained, the aim being to entirely obviate the use of liners, the gibs being replaced with the standard size when a certain amount of lost motion has manifested itself. This, of course, is a matter of detail generally left to the individual judgment of the superintendent.

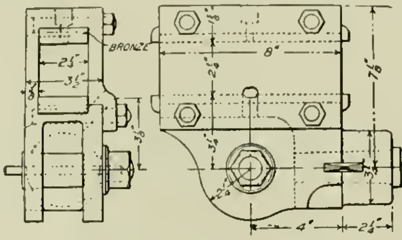
When the bottom guide is securely placed, the upper guide should be placed in position and also tried with the gauge or scale, noting that it should be parallel with the bottom guide, which, after being properly adjusted, becomes the basis of the operation. When both guides are attached it will be readily noted by the use of the straight edge and scale whether the upper guide is centrally located sideways as well as parallel with the central line. The crosshead may be calipered with gibs attached and the gibs so adjusted that the gibs may not require any liners. The crosshead may then be placed in the guides, and the gibs put in position and the outer plates attached, care being taken to note that the crosshead moves easily the entire length of the guides. Variations that may occur in the location of the holes in the guide blocks may be readily rosebitted, and new bolts fitted, care being taken that the clamps holding the guide and guide blocks together are properly secured against the contingency of moving.

In the older types of locomotives where four bar guides are in use, the same methods may be employed, the bottom

guides being set parallel, longitudinally and crosswise with the center line, an allowance of 1-32d of an inch being added to the distance between the bars, to allow for lateral motion in order to avoid excessive friction in the movement of the crosshead. When the bottom guides are properly placed the line may be dispensed with and the crosshead placed in position and the top guides adjusted to suit the crosshead. While the fine adjustment of the four bars is a more intricate task than setting the two-bar guides, they are more easily moved, in the event of tightening at some part of the crosshead's movement. A piece of paper inserted at a certain edge of the guide block will have the effect of slightly relieving the tight point.

A peculiarity in the refitting of guides and crossheads which will be noticed by the observing mechanic is that in stretching a line a considerable distance beyond the guides and measuring the distance that the line may be away from the frame, it will rarely be found that the line is exactly parallel with the frame. It will also be found that the lines passing through the two cylinders are rarely exactly parallel to each other. Original organic defects there may be, arising from the planing of the saddle and cylinder faces. Modern machine shop tools by their sheer weight and massiveness of construction turn out better work than the older and lighter machines. As is well known, cutting tools penetrate metals deeper at the beginning of the cut than at the end. The variation may be very slight, but when a number of planed surfaces are bolted together the variation becomes more apparent. In this connection it may be added that what is known as a slight shrinkage of the metallic molecules that are exposed to varied climatic conditions such as that which the front end of a locomotive experiences, whereas the back end of the cylinders and related parts may be said to be less exposed. Whatever of fact or fancy there may be in this theorizing, certain it is that the lines passing through the cylinders at different periods of the working life of a locomotive will be found to vary slightly and always in an outward direction. In cases where the hole in the guide block is found to be out of line with the hole in the guide, it is sometimes better practice to plug the hole through which the guide block is attached to the guide yoke, and proceed to drill a new hole rather than apply the rosebit, the fact that the guides frequently are hardened their entire length, thereby rendering the operation of rosebitting impracticable, unless a softening process be applied to the end of the guide.

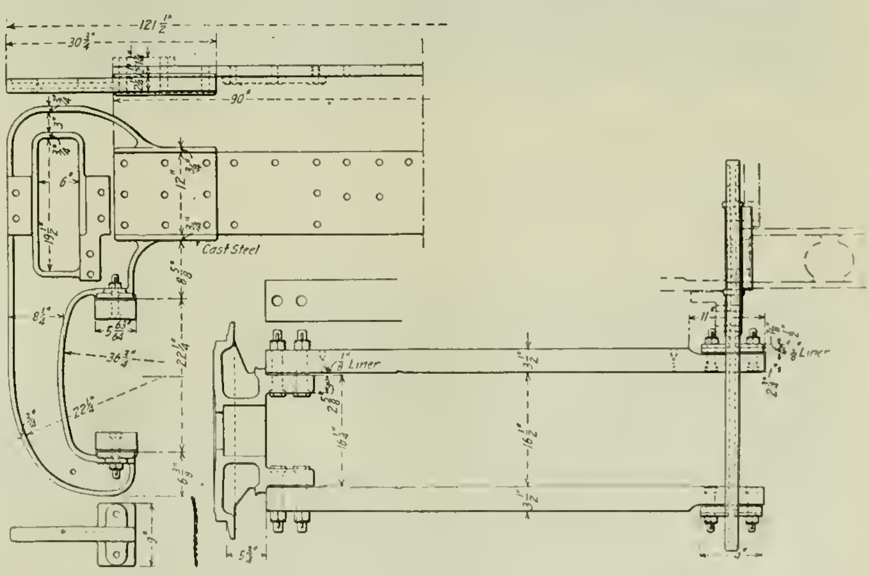
In the case of guides that are set above the center of the cylinder, it will readily suggest itself to the intelligent mechanic that the upper guide must first be placed in position and precisely adjusted by the center line to suit the distance from the crosshead center, the lower guide following by calipering and levelling as already described. In the case of the single bar guide, the crosshead and guide may be placed in position together and the line passing through the cylinder and through the hole in the crosshead, the crosshead being readily moved from end to end of the guide as required, and the guide adjusted to suit the requirements of the situation, as shown by the line in the hole in the crosshead.



SINGLE GUIDE CROSSHEAD.

A clever device has been used in some of the leading railroad shops in regard to babbitting crossheads. The single bar guide and crosshead being set in their proper positions, apart from each other, the cap and sides of the crosshead forming an enclosed vacant space, which is filled with the molten metal, which, when cooled, forms a perfect bearing with just sufficient clearance to make a fine running bearing, requiring no other adjustment until sufficiently worn to necessitate another application of a fresh supply of the molten compound. The oilway is provided for by a small rod extending through the cap of the crosshead, which is easily withdrawn when the metal has sufficiently hardened.

In conclusion it may be noted that while we have endeavored to be exact, as far as our space permits in describing what may be called some of the common practices in adjusting the guides and crossheads, there is much more that could be said upon the subject. Manly clever mechanics have tools of their own devising, designed to facilitate the work and obtain that degree of accuracy essential to the importance of the work. As shown in the accompanying illustrations, the bearing surfaces of crossheads and guides are made of such a shape and secured in such a way that the repairing or taking up of the wear usually means dismantling the crosshead or disturbing the guides. The latter is a prolific cause of resultant piston packing troubles, arising from the fact that the guides are not always set up true to the cylinders. In the case of being out of line, the guides cause the crosshead and piston to run out of line also, and therefore the packing does not have a fair chance to perform its special duty. When the crosshead is dismantled there are the usual number of fitted bolts to be loosened; with the customary result that one or more of them is damaged to such an extent that it cannot be used again. Often most of them will not have the proper draw when tried again, and the result is a full or nearly full set of new bolts to be made. With the numerous examples of substantial crossheads used in stationary practice that have ready and practical means for taking up the crosshead wear, it would seem as though our locomotive practice should develop a scheme for an easy adjustment for the inevitable wear. Some devices now being experimented upon are full of promise, and a general adoption of some such scheme would save much roundhouse labor, besides overcoming many difficulties arising from the annoying leaks so frequent in piston packing.



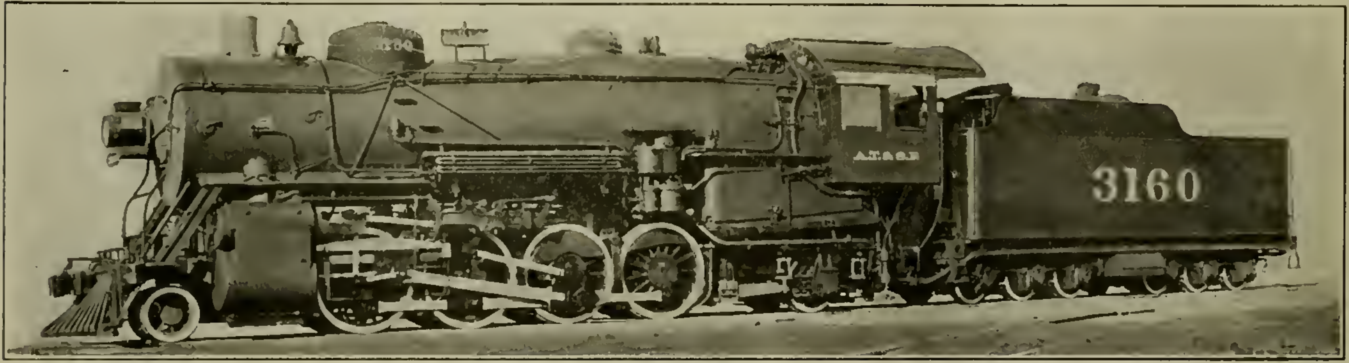
ALLIGATOR CROSSHEAD GUIDES AND CAST STEEL GUIDE YOKE.

To these general remarks we may add that we expect to be able to take up the subject again at an early date and present further means and methods used in adjusting the guides and crossheads.

Heavy Locomotives for the Atchison, Topeka & Santa Fe Railway Company

The Santa Fe System is now receiving, from The Baldwin Locomotive Works, a consignment of heavy Mikado or 2-8-2 type of locomotives. These engines use coal as fuel, and are intended for freight service on the Eastern Lines. They logically followed the lighter Mikado type of locomotives built in 1916. The new design was worked out conjointly by the railway company and the builders, and existing Santa Fé standards were used wherever possible throughout the construction. A comparison of the leading dimensions of the new locomotives with those of the previous type is as follows:

Date.	Cylinders.	Drivers.	Steam pressure.	Grate area.	Water heating surface.	Super-heating surface.	Weight on drivers.	Weight, total engine.	Tractive force.
1916.........	25" x 32"	57"	200	58.5	4,111	880	228,000	292,400	59,600
1917.........	27" x 32"	63"	190	66.8	4,614	1,086	228,900	314,900	59,800



S. L. Bean, Superintendent Motive Power. MIKADO LOCOMOTIVE FOR THE A. T. & S. F. Baldwin Locomotive Works, Builders.

Wheel load limitations prohibited a material increase in the weight on drivers, as compared with the design of 1916; and while the new engines are heavier, the additional weight is carried on the front and rear trucks. The principal advantage derived from this greater weight, is the increased steaming capacity of the enlarged boiler. With this additional steam supply, the larger cylinder horse-power, incident to the use of driving-wheels of greater diameter, can be developed. For an increase in total weight of not quite 8 per cent., there has been an increase in water heating surface of over 11 per cent. The starting or tractive force, with steam pressures giving approximately the same ratio of adhesion, is practically the same for both locomotives; but, as mentioned previously, the larger cylinders, wheels and boilers of the new engines, give them greater horse-power capacity. This additional power will be ulitized in maintaining higher speed with the same or possibly a little greater tonnage.

The boiler is of the extended wagon-top type, designed for a pressure of 225 lbs., but in service carrying 190 lbs. It contains a 43-element superheater, and the firebox is equipped with a brick arch supported on four tubes. An auxiliary dome, mounted over an opening in the shell, is of sufficient size for inspection purposes, and is placed back of the main dome and on the same course with it. A single liner is placed under both the domes, and they thus cover the longitudinal seam, which is on the right hand side. The boiler accessories include a power-operated fire-door and grate shaker. The minimum air opening specified for the ash-pan is 15 per cent. of the grate area. The throttle valve is fitted with an auxiliary drifting valve.

The cylinders are designed with direct exhaust passages of ample area, free from abrupt bends. Gun iron is used for the cylinder and steam chest bushings, piston and valve, bull and packing rings, and crosshead shoes. The piston heads are of rolled steel, and the crosshead bodies of .40 carbon cast steel of the Laird design. Special steels are used for the piston rods, valve stems, main and side rods and main crank pins. The Baker valve motion is applied, and is controlled by the type "B" Ragonnet power reverse gear. Fifty per cent. of the weight of the reciprocating parts is balanced.

The frames are of substantial design, the main sections having a width of 5½ ins., while the depth over the front driving pedestals is 8½ ins., and over the remaining pedestals 7½ ins. The top and bottom rails are tied together between adjacent pairs of pedestals, by strong vertical ribs of I-section. These ribs carry the equalizing beam fulcrum pins, which are fitted into case-hardened bushings. Transverse braces are applied at each pair of driving pedestals. Three of these braces, two at the second pair of pedestals and one at the fourth pair. These not only brace the pedestals through their entire depth, but are also extended to form long braces for the top rails. They support, respectively, the guide yoke, valve motion bearer, and a boiler waist sheet.

The shoes and wedges are of cast steel, and the driving boxes are of the same material, with brass hub faces. Long main driving boxes are used. The tires are all flanged, and flange oilers are applied to the leading drivers. The leading truck is of the Economy constant resistance type, and the trailing truck is of the Hodges type. Each truck is equalized with two pairs of driving-wheels. The arrangement of cross equalization frequently applied by the builders, consisting of two transverse beams connected by a central, vertical link, and it is here used between the rear drivers and truck.

The cab is placed well back, thus providing ample deck space. Special attention has been paid to the arrangement and placing of the cab fittings, in order to have all levers, valves, etc. within easy reach of the crew, and to place the steam, air and water gauges where they can be easily seen and read.

The tender is carried on two six-wheel trucks, which are equipped with clasp brakes and Standard rolled steel wheels. The tender frame is of cast steel, made in one piece. The buffer between the engine and tender is of the radial type. A coal pusher is applied.

These locomotives, in accordance with Santa Fé practice, are fitted with steam heat equipment so that they can, in cases of emergency, be used on passenger trains. Their leading dimensions are given in the table, as follows:

Gauge, 4 ft. 8½ ins.; cylinders, 27 x 32 ins.; valves, piston, 15 ins. diam.

Boiler—Type, wagon-top; diameter, 82 ins.; thickness of sheet, ¾ in., 27/32 in., ⅞ in.: working pressure, 190 lbs.; fuel, soft coal; staying, radial.

Firebox—Material, steel; length, 114 ins.; width, 84¼ ins.; depth, front, 88 5/16 ins.; back, 78 5/16 ins.; thickness of sheets, sides, ⅜ in., back, ⅜ in., and crown, ⅜ in.; sheet tube, ½ in.

Water Space—Front, 6 ins.; sides, 5 ins.; back, 4½ ins.

Tubes—Diameter, 5½ and 2¼ ins.; material, 5½ ins., steel; 2¼ ins., iron; thickness, 5½ ins., No. 9 W. G., 2¼ ins., No. 11 W. G.; number, 5½ ins.; diameter, 43 ft. 2¼ ins., 252; length, 20 ft. 9 ins.

Heating Surface—Firebox, 232 sq. ft.; tubes, 4,348 sq. ft.; firebrick tubes, 34 sq. ft.; total, 4,614 sq. ft.; superheater, 1,086 sq. ft.; grate area, 66.8 sq. ft.

Driving Wheels—Diameter, outside, 63 ins.; diam. center, 56 ins.; journals, main, 12 x 20 ins.; journals, others, 11 x 12 ins.

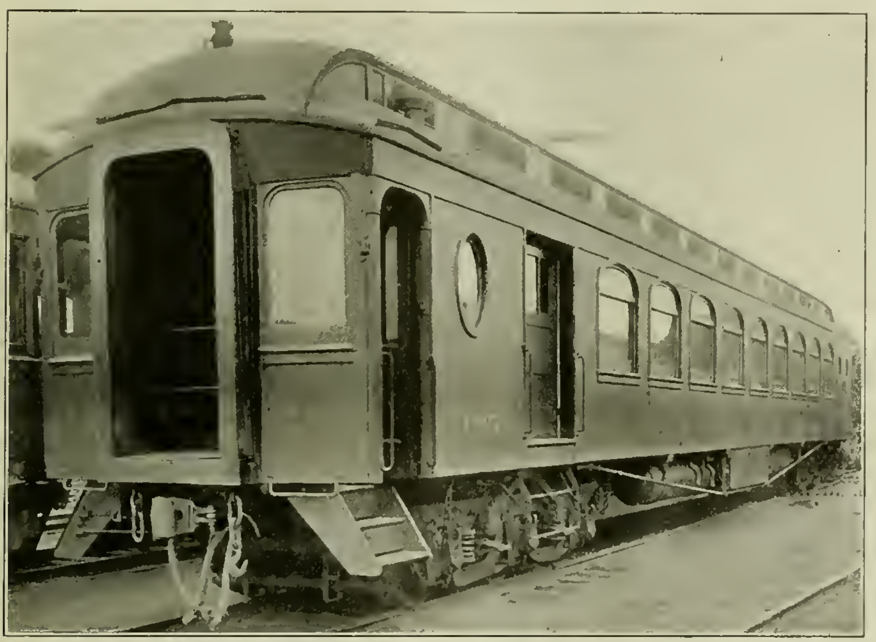
Engine Truck Wheels—Diameter, front, 31¼ ins.; journals, 7 x 12 ins.; diameter, back, 40 ins.; journals, 9 x 14 ins.

Wheel Base—Driving, 16 ft. 6 ins.; rigid, 16 ft. 6 ins.; total engine, 35 ft. 1 in.; total engine and tender, 71 ft. 8⅝ ins.

Weight—On driving wheels, 228,900 lbs.; on truck, front, 31,000 lbs.; on truck, back, 55,000 lbs.; total engine, 314,900 lbs.; total engine and tender, 563,900 lbs.

Tender—Wheels, number, 12; diameter, 35 ins.; journals, 5½ x 10 ins.; tank capacity, 12,000 U. S. gals.; fuel capacity, 16 tons; service, freight.

Hospital Car for the Erie Railroad

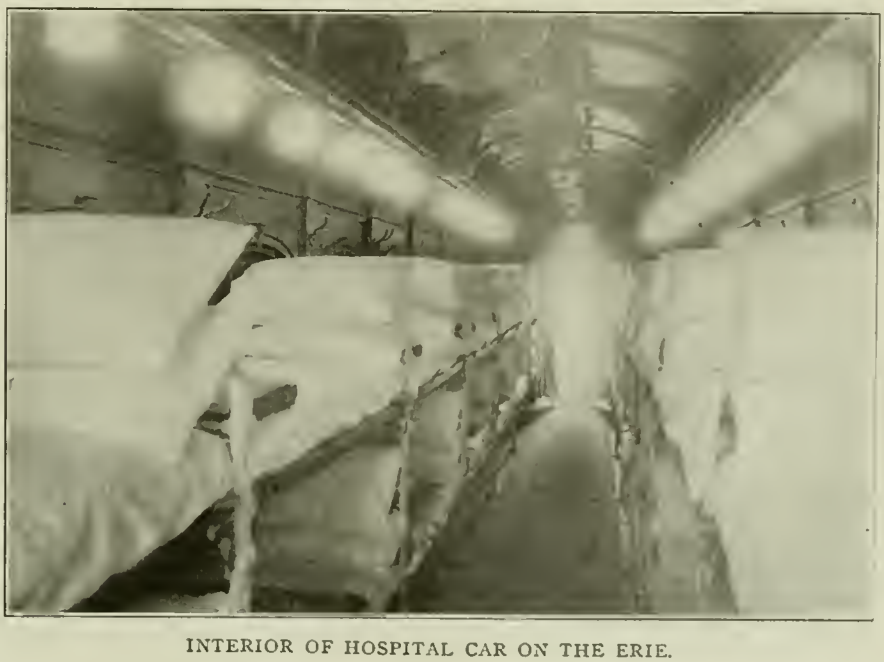


END AND SIDE VIEW OF ERIE HOSPITAL CAR.

Hospital car No. 1097 has been stationed in Jersey City on the Erie Railroad, where it may be held in readiness for government service. It will probably be used to transport sick soldiers from the various cantonments to the base hospitals. It may even carry those invalided home from foreign service, if such misfortune is for us. Competent physicians who have inspected the new car say that it is an up-to-date hospital equipment. One of the Erie Railroad steel underframe parlor cars, No. 983, was selected as the most suitable for conversion into this hospital car. The vehicle measures 70 ft. over the body end sills and is therefore of very large capacity.

A receiving and supply room 10 ft. 8½ ins. long, with a sliding door at each side, has been fitted up at one end of the car. At the other end, there is a small rest room, provided with a sofa and lavatory. The main portion of the car is about 50 ft. 6 ins. long and contains seven two-cot on each side, and has, therefore, capacity for 28 patients. The "two-story" cots are of a new design furnished by Frank A. Hall & Sons, of New York. The springs of these cots are adjustable to any desired position to suit an injured patient's back or legs. The cots are finished in white enamel.

The supply room contains a fireless cooker, a drinking water tank, a wash basin and supply locker. The annunciator on which calls from any part of the car are indicated, is also placed here. The car is equipped with electric lights, the current being furnished by an axle generator. The electric lighting fixtures are on the side decks. Emergency lights are provided by Pintsch gas lamps located in the center of the upper deck. The interior finish of the new hospital car is a light gray, which is very pleasing in appearance. From a humanitarian standpoint it is hoped that there will be but little use for the new car, but in case of need the Erie is in position to furnish a good, commodious and up-to-date hospital car. Our illustrations give a very good idea of the appearance of the new car, showing both the outside and the inside of the car.



INTERIOR OF HOSPITAL CAR ON THE ERIE.

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Unscientific Measurement of Light.

In glancing at the order of the Interstate Commerce Commission regarding locomotive headlights, which order we print in another part of this paper, we find that section 129 specifies that each locomotive shall have a headlight sufficient to give illumination to a person in the cab, who possesses the usual visual capacity required of enginemen, to see through a clear atmosphere a man on the track 800 feet in front of the light. This is practically a test of vision, not a measure of the intensity of light. The usual test applied to enginemen is for color, and in an article in the *Century Magazine,* written some years ago by Dr. Edward A. Ayers, he says:

"There are two kinds of light waves emitted from all objects—color and white waves. Whenever a source of light, as the sun, strikes an object, part of that light is absorbed and part reflected. The latter represents such object's 'luminosity.' The color-blind are never blind to this form of light." In the absence of the sun, as at night, even without the moon, there is usually a feeble diffused light. The headlight takes artificially, the place of the sun. Color-weak vision (for total color blindness is rare) will show objects to the observer, but the ability to see a man 800 feet ahead probably varies very considerably from one observer to another. Any deficiency which may exist must be made up by a re-adjustment of the headlight. Poor vision requiring a powerful light and good vision doing very well with a feeble light. As the power of vision varies, from man to man, the power of the light may be altered in inverse proportion. Here are two variable factors introduced into the problem.

Even supposing that such men and such headlights were co-ordinated so as to effect the desirable result of seeing a man on the track 800 feet ahead, all might be well, as far as saving the man on the track is concerned, but the various powered headlights would be run in the opposite direction to trains on an adjacent track. Here it is quite possible for a poor-vision man, with an intense and concentrated beam of light from his lamp, to temporarily blind a man on a train running in the opposite direction on the other track. The adjustable headlight, if such were used, helps one man and handicaps another. Further than this, how is the headlight left at high power by a poor-vision man, to be quickly readjusted for a good-vision man who has to go out on the road in a hurry, and who has no obliging and fearless friend to stand 800 feet in front of the onrushing train, and wait until he is "focused" as a photographer might do, by the good-vision man with the low-burning lamp? This adjustment and readjustment would constitute a technical compliance with the order. The whole matter may easily have its aspect changed by the variations of wind and weather, snow or rain.

Mr. George H. Stratton, the psychologist, says: "Even in the quiet of the psychological laboratory, the errors which a person will make in trying to direct his eye with speed and accuracy toward a given point, surprise us by their largeness. He may feel confident that he has swept his glance clear to the point selected, yet a record taken by exact photography will often show that he did not look directly at the point at all; his *attention* made the full sweep to the goal, but his *eye* lagged far behind."

Attention plays a large part in the ability to "see" things. A case was noted where a man, in a test, on the engine, looked for a man on the track, and "saw" one, when no man was there, and the expert in charge had secretly prohibited any man from walking the track for that particular experiment. In certain psychological states persons see the things they are expecting, hoping or fearing to see, although these may all be hallucinations. A case was given by a correspondent, some years ago: "There was a mine in which horizontal passages connected with a vertical shaft, at different levels. In the vertical shaft was a cage for carrying cars of coal to the surface. Occasionally a miner would shove a loaded car of coal off into the empty vertical shaft. In many such cases the miner reported that he actually saw the cage waiting to receive the car. Psychological investigation proved that this was true. For some reason the miner 'saw' what he expected to see, and not what was actually there." The vagaries of even close-up sight is here exemplified, and other similar cases exist.

The specification of light judged by the work to be done by a man, with all his fallible tendencies of eye, attention, and observation, does not seem to be what might be considered a scientific standard of light, however, desirable the object to be attained, may be. The intensity of light should be stated in candlepower, which is a recognized standard, and can be tested for by the photometer with the highest accuracy. Very many of our railways do not object to the use of such a standard when stated as a minimum, if they be allowed some judgment, when guided by the conditions of track and traffic, which vary from one road to another. Each railway manager, looking squarely at his own conditions, is unconcerned with a different set, which may obtain on a neighboring road or on one traversing an entirely different country from his own. Each is ready to accept the specified and uniform minimum for his road, yet each wishes to provide his enginemen with a headlight best suited to the needs of the road, having always the supreme duty before him of securing full safety for the traveling public, the man on the track and the engineman who requires a satisfactory tool for this work as well as for any other of his onerous duties which our growing complex mechanisms have called into service.

Passing Over Curves.

Among questions frequently submitted to us by disputants there are few more frequent than the ever-recurring question of the slipping of locomotive wheels when passing around curves, and, while we prefer answering questions by letter, it may at this time be stated for the benefit of some of our readers that locomotive wheels are beveled on the bearing rims to assist in passing around curves. It can be seen at a glance that the natural tendency of the locomotive to run in a straight line has the effect of pressing the flange of the wheel against the outer rail when passing around a curve. The larger diameter of the wheel being near the flange, each revolution of the wheel must necessarily traverse through more space than the wheel passing around on the inner rail of the curve. As curves are variable, it would be impossible to have the rims so beveled as to suit every degree of curve. Hence the beveling of the rim is merely an engineering effort to aid in the purpose aimed at.

The raising of the outer rail has nothing to do with the problem of partially solving the question of varying the diameter of the periphery of the wheels, but has the effect of overcoming the tendency of the locomotive to exert undue pressure on the outer rail. It has been observed that many derailments occur at curves, occasioned largely by passing around curves at high velocities, when the tendency to jump over the outer rail is very great on account of the momentum of the locomotive furnishing an increased force to move in a straight line.

It has also been observed that even when the rims of the wheels are deeply worn they are always larger near the flange, and hence the effect of the beveling of the face of the tire is not altogether lost. That a certain amount of slippage occurs on the inner wheel when worn is unquestioned, but under the varying conditions of curves and varying velocities, slippage also occurs on the outer wheel. As it is impossible to adapt the raising of the rail to the varying velocities, so it is also impossible to maintain the rims of the wheels to the exact requirements of each particular situation, the united effort in beveling the rims and varying the elevation of the rails as well as varying their width being only partially successful.

It may be noted that in the latter regard, the widening of the rails is also serviceable in allowing the locomotive to pass around a curve, as the rigid wheel requires some added clearance where the rails are not in a straight line, and where the amount of lateral motion in the locomotive bearings is necessarily limited.

Claims That the Shop Made Him.

One expression that used to be common with machine shop superintendents was, "we made that man and it is shameful that he should go away when he is becoming useful."

We were recently very much struck with that expression as used by a machine shop proprietor when a young man was leaving to better himself, after a term of service extending over six years. The old gentleman was quite honest and sincere in what he said, although it was a fact entirely apparent to anyone familiar with the circumstances, that the young man had, as machinist and draftsman, simply made himself by hard work at the bench and drawing table during shop hours, and, in some cases, still harder work over books in other hours, and instead of having been "made" by the shop, had along with a few others of the more progressive and intelligent men about the place, succeeded in keeping it somewhere near up-to-date, all the while contending against the stupid and narrow-minded conservatism of the proprietor, whose instinct made him oppose everything that looked like the least deviation from the practice that had been followed there for twenty-five years.

The young man, as we happened to know, was leaving simply because too much vitality and nerve force were used up in simply overcoming utterly unreasonable objections to progress, and he was going where he believed there would be fewer hindrances to his work and the making of himself.

A successful shop proprietor lays down a general plan upon which he proposes to operate his establishment. In carrying out his plans he selects from those who are available, the men whom he thinks are best suited for the various positions of responsibility. These men usually owe their selection to something which is within themselves. They are not selected to be made, but because they have, to a greater or less extent, been already made, and are supposed to be capable of assisting in the work of making a shop and its products. They are not usually given more of either money or opportunity for advancement than they show themselves clearly entitled to, as in most cases if advancement is not possible where they are, it will be attained somewhere else—other employes will come to recognize their ability, and their success or failure will depend mainly upon themselves, and very little upon others, who may or may not imagine they are making the first class workmen.

Shop organization has, of course, an influence upon men, and may keep or retard their development, but the fact that no one claims to have made a man who is a failure, in itself proves that the degree of success he attains is by the same token due primarily and mainly to himself, so the shop proprietor who talks of "making" the successful man who has worked for him, should, to be consistent, also claim to be the maker of the unsuccessful ones, but we never heard of any of them doing it.

Lightness in Construction.

Referring to the article in this issue descriptive of guides and crossheads, some remarks might have been added in regard to the marked improvements in the lightening of designs of crossheads, pistons and other reciprocating parts, but as the subject has been fully discussed in a recent issue of RAILWAY AND LOCOMOTIVE ENGINEERING, little further need be said at present other than that the marked advance toward a greater degree of lightness in construction has been made possible by the development in alloy steels. Among these chrome-vanadium steels are, in their physical properties, much like chrome-nickel steels, but they have a greater contraction of area for a given elastic limit than the latter. This higher degree of contraction in the pulling test is associated with a more ready adaptability to machinability, as chromo-vanadium steel, with an elastic limit of 150,000 lbs. per square inch, may be machined rapidly, whereas a chrome-nickel steel, with an elastic limit would quickly dull the cutting tool if cut at the same speed. Vanadium, when present, favors quality. When used in high duty forgings and structural parts of machines, a lesser amount of weight of material will suffice for the service. Hence it is not surprising that as the weight of locomotives are increasing, the weight of pistons, crossheads, guides and other parts are diminishing. Indeed, it has been claimed by high authorities that the addition of 0.06 per cent of vanadium to a one per cent carbon steel raises the yield point from 79,000 lbs. to 156,000 lbs., or 44 per cent ultimate strength from 134,000 to 193,000 lbs. It is not surprising, therefore, that lighter weights of the parts to which we have referred are rapidly coming into general practice.

The Taking Over of the Railroads.

President Wilson has assumed control of the railroads during the war. As we pointed out, the British government took similar action immediately after the declaration of war in 1914. As described in the December issue of RAILWAY AND LOCOMOTIVE ENGINEERING, page 409. Railroad security holders are to be guaranteed a return equal to that of the three years preceding. The present force of employes will not be disturbed, except in such instances as a glaring need of change may manifest itself. That there will be a marked increase in the efficiency of the railroads is beyond a doubt owing to the complete elimination of competition. National necessity requires that traffic be carried over the lines that can handle it with the greatest expedition, and this necessitates the taking it away from roundabout or from temporarily congested roads.

The chances for the government making a certain amount of profit are excellent In Great Britain a saving of $150,000,000 per year has been effected by the government operation of the roads. A great saving has been made in the accounting department because interline accounting disappears, and there are savings in administration expenses. Not only so but the constant uncertainty in regard to rates, the ever-recurring menace of strikes will also disappear and something approaching a national system of railroads will fall upon us like a blessing. What it will be after the war is not hard to predict. It will not be government ownership. It is sufficient to say that it will never likely fall back into the old system of ruinous competition with the aggravating condition of seeing a large portion of the railroads in bankruptcy, while a few better located are flourishing in wealth.

Air Brake Department

Brake Cylinder Leakage—Porosity of Leathers No Longer A Cause of Leakage—Questions and Answers

Paragraph No. 14 of the Rules and Instructions for inspection and testing of steam locomotives and tenders, as revised and approved by the Interstate Commerce Commission, February 1, 1917, reads in part, "With a full service application from maximum brake pipe pressure, and with communication to the brake cylinders, closed, the brakes on the locomotive and tender shall remain applied not less than five minutes."

The original idea was to limit the brake cylinder leakage to 5 lbs. per minute per cylinder, but after some tests it was decided that this would be unnecessarily severe, especially as a leakage of 5 lbs. per minute in a locomotive driver brake cylinder with 4 inches piston travel, would not be in excess of 2½ lbs. per minute with the same diameter of cylinder on a car when the piston travel was 8 inches, and it was then pointed out that inasmuch as 5 lbs. per minute leakage from a brake cylinder with 8 inches piston travel would double to 10 lbs. per minute if the piston travel was taken up to 4 inches, or if the brake cylinder volume was halved, the opening through which leakage was escaping remaining unchanged, and with the result that the compromise quoted was established.

When this ruling went into effect, it was hailed with delight by those who were not in the habit of attaching air gages to locomotive brake cylinders for tests, and they naturally assumed that it would be the easiest thing in the world to keep locomotive brake cylinders in a condition that the brake would remain applied for a period of five minutes with communication to the brake cylinders closed, and it is not such a difficult matter if the cylinders are so located that heat from the boiler or firebox is not transmitted to the interior of the cylinder and where there are but two driver and one tender brake cylinder per locomotive, but others who have had considerable experience with cylinders located at points where the temperature was high and had engine truck and trailer brake cylinders connected with the driver and tender brake cylinders, stated flatly that the portion of Rule No. 14, quoted above, was the most difficult paragraph to comply with in the entire set of Rules and Instructions.

Recognizing this condition, the Pittsburgh Air Brake Club, at one of their meetings, appointed a committee to report on the subject of "Cause and elimination of leakage in driver brake cylinders." All of the members took active interest in the subject, extensive tests were conducted with various kinds of lubricant, experiments were made with various kinds of chemicals for the composition of the filler forced into the pores of the leather to keep it air tight, and in an effort to obtain a filler that would remain in the leather under high temperature the experiments reached a stage where the leathers became so hard and brittle that they could be broken like glass when cold. The members of this club finally reached the conclusion that it would be impossible to secure a packing leather that would remain air tight and give satisfactory results in locomotive brake cylinders that were subjected to a high temperature from the boiler, firebox, or cylinder saddles.

During some tests leathers were applied to cylinders and a leakage test would at that time show but from 1 to 3 lbs. per minute, and in 24 hours time another test on the same cylinders would show from 25 to 30 lbs. leakage per minute, principally because the high temperature had destroyed the filler in the leather and the compressed air was forcing itself through the pores. The chemists of the Air Brake Company were consulted, and members of the committee worked with them in an effort to find a substitute for the leather, and for some months there was very little promise of success, but at the present time we are proud to state that this, like many other air brake problems, has been solved, and a composition packing cup has been developed to take the place of the brake cylinder packing leather.

These cups have been undergoing tests under conditions where the packing leathers showed 25 or 30 lbs. leakage per minute a short time after being applied, and after 6 months service show no leakage and practically no indications of wear, and one railroad has about 1,400 engines equipped with the packing cups which are giving entire satisfaction.

With the understanding that the Air Brake Department of this magazine is not an advertising medium, it will not be out of place to state that the packing cups to replace the packing leathers are being manufactured by both the Westinghouse Air Brake Company and the H. W. Johns-Manville Company and possibly by other companies, but we are unable to state whether both products are of the same material and know nothing whatever of any comparison between the cups, only that at the present time the price of the cup is a trifle higher than the price of a packing leather for the same diameter of cylinder. The object in stating this is to inform our readers of the fact that locomotive brake cylinder leakage may now be kept within a very reasonable limit, in fact, indications are that by the use of the packing cup it may be brought down to a point where the original recommendations would not be unreasonable, as leakage through the leather is eliminated, and we believe that this has been accomplished largely through the efforts of the members of the Pittsburgh Air Brake Club.

Locomotive Air Brake Inspection.

(*Continued from page 399, Dec., 1917.*)

150. Q.—Is there any possibility of forgetting to re-open the cocks to allow the engine to leave the inspection pit with the brake cut out or the pump throttle closed?

A.—No. These leakage tests are all completed before the brake valves are used or tested.

151. Q.—When is the main reservoir pressure controlled by the maximum governor top?

A.—When the automatic brake valve is in lap, service or emergency positions.

152. Q.—Can a feed valve be tested with 110 lbs. pressure in the brake pipe and 120 lbs. pressure in the main reservoir?

A.—No accurate test can be obtained.

153. Q.—Why not?

A.—Because the tension of the supply valve piston spring of the feed valve ranges from 7 to 12 lbs., and with but 10 lbs. difference between the brake pipe and main reservoir pressure, the feed valve could not be expected to operate correctly.

154. Q.—What force then actually operates the brake pipe feed valve?

A.—The difference in pressure in the main reservoir and brake pipe.

155. Q.—In what position of the brake valve is the feed valve operated?

A.—Running and holding positions.

156. Q.—What air pressure will be in the application cylinder and release pipe with the brake valve handle in running position and the brake released?

A.—Atmospheric.

157. Q.—Could the brake be applied while both the automatic and independent brake valves are in running position?

A.—Yes, if the brake pipe and pressure chamber of the distributing valve have been overcharged.

158. Q.—What then prevents the escape of application cylinder pressure through the release pipe?

A.—The movement of the equalizing slide valve to lap position which sepa-

rates the application cylinder and release pipes.

159. Q.—At what time is there air pressure in the application cylinder pipe?

A.—At all times the brakes are applied.

160. Q.—At what times is there air pressure in the release pipe between the brake valve and the distributing valve?

A.—At times when the brake is applied with the equalizing slide valve in release position, or after the equalizing slide valve has assumed release position with either one of the brake valves away from running position.

161. Q.—How is the brake applied with the equalizing slide valve remaining in release position?

A.—With the independent brake valve.

162. Q.—When is there air pressure in the release pipe branch between the brake valves?

A.—Only when the automatic brake valve is in holding or release positions after a brake application.

163. Q.—How is this pipe tested for leakage?

A.—By having the automatic valve in holding position and making a full application with the independent valve and returning the independent valve to running position.

164. Q.—It is understood that all piping is to be free from leakage, but what 3 pipes on the locomotive must be maintained absolutely tight?

A.—The application cylinder pipe, the equalizing reservoir pipe and the equalizing reservoir gage pipe.

165. Q.—What must be observed in the way of preventing vibration of the brake valves, feed valve and reducing valve and signal valve?

A.—That these parts are securely tightened to their respective brackets and that the brackets are tight on the boiler or on whatever parts of the locomotive they happened to be fastened.

166. Q.—What is the first thing that should be observed when placing the hand on the handle of the automatic brake valve?

A.—That there is no undue lost motion between the valve handle and rotary valve key, or between the key and the rotary valve, and that the valve handle works freely.

167. Q.—What is the effect of considerable lost motion between the brake valve handle and the rotary valve key?

A.—It tends to produce imperfect port openings when the handle is in running and service application position.

168. Q.—When does this disorder become annoying?

A.—When the port opening is not properly made with handle in running position, where the flow of air from the application cylinder will be restricted, causing a slow release of brakes on the engine.

169. Q.—With full air pressure in the brake pipe and main reservoir, how is the brake valve test to be made?

A.—By first making a 5 lb. brake pipe reduction with the automatic brake valve in service position.

170. Q.—What should be the result of this?

A.—An application of the brakes on the engine and tender.

171. Q.—What is wrong if the brake does not apply?

A.—There is an undue amount of friction in the equalizing or application portion of the distributing valve, that is, the distributing valve is not sufficiently sensitive, or the valve may be of the retarded application type.

172. Q.—Why are distributing valves of a retarded application type used?

A.—To operate with modern passenger car brake equipments that have these features to the intent that brakes on engines and cars will apply uniformly.

173. Q.—How much brake pipe reduction is required to apply the retarded type of distributing valve?

A.—Between 8 and 10 lbs.

174. How is this retardation of the application of the distributing valve accomplished?

A.—Through adding a filling block chamber between the distributing valve and reservoir and having additional ports leading from the pressure chamber to the filling block chamber so that the first movement of the equalizing piston and attached graduating valve will admit air from the pressure chamber to the filling block chamber.

175. Q.—How long does this flow continue during a brake pipe reduction?

A.—Until the pressure chamber and filling block chamber have equalized.

176. Q.—At what pressure do they equalize?

A.—At 105 lbs. from a 110 lb. brake pipe pressure.

177. Q.—What happens after equalization, if the brake pipe reduction is continued?

A.—After sufficient differential in pressure is obtained to move the equalizing piston with the equalizing slide valve attached, the brake applies in the usual manner.

178. Q.—What would be wrong if this type of valve applied with 5 lbs. or a trifle more brake pipe reduction?

A.—It would indicate that the filling block chamber had been removed or that the port leading to it from the pressure chamber was stopped up or that in making repairs a standard type of equalizing slide valve or graduating valve had been used.

179. Q.—Why does this type of brake release with the brake valve in release or holding position after an application?

A.—Because the release pipe between the brake valves is usually disconnected when this feature is applied.

180. Q.—With the standard type of brake, if the brake will not apply with a 5 lb. brake pipe reduction, how will it be determined whether the equalizing or application portion is at fault?

A.—This will be determined by the independent brake valve test.

181. Q.—What else is to be observed during the first 5 lb. brake pipe reduction?

A.—That the equalizing piston of the brake valve responds promptly, and discharges brake pipe pressure, and that it closes off tightly, and that the compressor governor is sensitive enough to permit the compressor to start promptly as the brake applies.

182. Q.—After the first 5 lb. reduction, how much should the next be?

A.—5 lbs. more, to see that approximately 25 lbs. brake cylinder pressure is obtained for the total 10 lbs. reduction.

183. Q.—How much should the next reduction be, and why?

A.—10 more pounds, which should develop 50 lbs. brake cylinder pressure and the object is to ascertain the proper amount of brake cylinder pressure per pound of brake pipe reduction is obtained.

184. Q.—What is the amount of the next brake pipe reduction, and for what purpose?

A.—15 more pounds to see that brake cylinder pressure does not increase above 68 lbs., the adjustment of the safety valve of the distributing valve.

(To be continued.)

Train Handling.

(Continued from page 400, Dec., 1917.)

168. Q.—Can it be modified for trains of all loaded or all empty cars?

A.—It can be without any serious results, but as a general proposition, the method outlined will produce the smoothest stop.

169. Q.—What kind of an application would be made if the make up of a train of empty and heavily loaded cars was just the reverse, that is, if the loads were behind the empty cars?

A.—The same light initial reduction.

170. Q.—Would it be best to make the initial reduction with the engine throttle open?

A.—No.

171. Q.—Why not?

A.—It would not then be desirable to keep the train stretched.

172. Q.—Why not?

A.—Because the slack would be bunched by the influence of the brake application through the loads crowding against the empty cars on the head end.

173. Q.—What would be the logical way of attempting to control the slack action under such a condition?

A.—To bunch the slack with a light application of the independent brake before

the automatic brake valve was used.

174. Q.—Please explain just why this would be done to produce a smooth stop or to prevent a rapid change in slack?

A.—Under this condition, the loaded cars tend to run a further distance than the empty cars, therefore they would run into the empties from the rear, and the brake application would become effective on the head cars first, therefore there would be no chance of a change in slack, if the slack was bunched or gathered in before the brake application on the train was started.

175. Q.—How are you guided then if the empties and loads are mixed indiscriminately through a train?

A.—By noting in which direction the slack runs during the first brake application.

176. Q.—Why are trains of all loads or all empty cars so much easier to handle than mixed trains?

A.—Because there is no tendency for a harsh run out of slack in either direction as a result of a brake application.

177. Q.—Why not?

A.—The brake application becoming effective on the head cars first, tends to gather in the slack on the head end, and there is nothing particular except track conditions that would have a tendency to cause a runout of slack thereafter.

178. Q.—Would you in all cases use the light initial reduction for making a stop with a freight train?

A.—Yes, provided that there was ample distance in which to make the stop.

179. Q.—Why?

A.—In order to be on the safe side of any adverse track conditions, or in cases of defective or inoperative brakes having a tendency to change the run of slack.

180. Q.—Would an allowance be made for a brake application if the rear of the train happened to be rounding a curve, or be on a reverse curve?

A.—Yes, the effect of the curve would be to add considerable retarding force to the brakes at the rear end of the train.

181. Q.—How would a train of all empties or loads be handled under this condition?

A.—As though the greater percentage of braking power was at the rear end of the train, as the greater retarding effect would be under such conditions.

182. Q.—How is a stop to take water made?

A.—With the same light initial brake pipe reduction, far enough away from the water plug for this application to stop the train before the plug is reached.

183. Q.—How will water then be taken?

A.—By cutting off the engine and running up to the plug.

184. Q.—What if the speed is high?

A.—Follow with the second reduction to bring the speed down to 18 or 20 miles per hour and release and recharge for the final application for the stop at tank.

185. Q.—How about pulling into a side track?

A.—The same method would be employed.

186. Q.—What about the Brakeman's objection to walking some distance to the switch if the distance of the stop is misjudged?

A.—It is easier for him to walk a few hundred feet and open a switch than to drag up enough chain to get the train together if you happen to part it.

187. Q.—What is a good general rule to follow in this respect?

A.—Attempt no spotstops with a long freight train.

188. Q.—How about backing into a siding?

A.—The stop should be made in the same general way, but under ordinary circumstances the application should be made with the engine throttle open and the independent brake valve in release position.

189. Q.—For what purpose?

A.—To offset so far as possible the tendency for the slack to run out or away while the brakes on the head end are applying.

190. Q.—What should the train crew do in a case of this kind?

A.—Apply enough hand brakes on the rear end of the train to prevent the slack from running out harshly.

191. Q.—How is the brake valve handled in case of emergency?

A.—It is placed in emergency position and allowed to remain there until after the train has stopped.

192. Q.—How is a release of brakes made after an application?

A.—By placing the brake valve handle in release position.

193. Q.—Why not in running or holding position?

A.—Because release position was incorporated for the purpose of emptying the main reservoir pressure into the brake pipe for a sudden increase of brake pipe pressure with which to accomplish a release, at least so far as the head end of the train is concerned, the increase will be rapid.

194. Q.—Why is the increase slower with the valve handle in running position?

A.—Because in this position all the pressure that enters the brake pipe must pass through the feed valve and the openings are smaller.

195. Q.—Why are they smaller?

A.—Principally so that it will not maintain excessive leakage and that the brake can be applied with a conductor's valve or a back-up hose while air pressure is feeding from the main reservoir to the brake pipe.

196. Q.—About what is the size of the opening into the brake pipe with the brake valve handle in release position?

A.—About one-third of a square inch.

197. Q.—How may this expression be confused?

A.—By the term one-third of an inch square.

198. Q.—For what length of time is the brake valve placed in release position to accomplish a release of brakes?

A.—It depends upon air pump and main reservoir capacity, length of the train, type of triple valves in use and the amount of brake pipe reduction that has been made.

199. Q.—Assuming an ordinary total reduction of 20 lbs. on a train of 100 cars, having both H and K triple valves, and with modern main reservoir and air pump capacity, how long would the brake valve handle be allowed to remain in release position?

A.—From 15 to 20 minutes.

200. Q.—Why not longer?

A.—To prevent an unusually high overcharge of the auxiliary reservoirs at the head end of the train.

201. Q.—What would be the result of this overcharge?

A.—A heavy re-application of the brake on the overcharged cars.

(To be continued.)

Car Brake Inspection.

(Continued from page 401, Dec., 1917.)

169. Q.—How is the brake cut out?

A.—By closing the stop cock in the brake pipe branch pipe leading to the triple valve and bleeding the air pressure out of all of the air brake reservoirs on the car.

170. Q.—How can the universal valve be cut out for a brake rigging defect?

A.—By means of the brake cylinder pipe cut out cock, leaving the reservoirs charged for operating the water raising system.

171. Q.—How can a triple valve equipment be cut out and still leave the auxiliary reservoir charged to operate the water raising system?

A.—By closing the cut out cock in the branch pipe and then bleeding the auxiliary reservoir, then open the cut out cock a trifle, or just a sufficient amount to start a flow from the reservoir bleeder cock, then close the bleeder cock and leave the reservoir charge up. The plug at the opposite side of the pipe connected to the high speed reducing valve should be removed or the reducing valve pipe be disconnected.

172. Q.—What could be wrong if a signal to apply brakes is given and the brake pipe, exhaust port of the brake valve will not close?

A.—The yard plant might still be connected with the train; otherwise the brake on the engine is defective.

173. Q.—What might be wrong if two engines were coupled to the train?

A.—The brake valve cut out cock of

the second engine might be open.

174. Q.—What might be wrong if the brakes could not be applied from the first engine of a train, and they could be from the second?

A.—One of the brake pipe angle cocks between the engines might be closed.

175. Q.—Who should be aware of this?

A.—The engineman in charge of the first engine.

176. Q.—Why so?

A.—He would know from the length of the brake pipe exhaust that the brake pipe of a train of cars was not coupled.

177. Q.—What should be done if a freight car is to be made up in a passenger train?

A.—If it has a K triple valve it should be replaced with one of the H type and a safety valve should be screwed into the brake cylinder connection.

178. Q.—To what pressure should this safety valve be adjusted?

A.—About 60 lbs.

179. Q.—Why should the retaining valve pipe be disconnected if special instructions do not prohibit?

A.—So that the exhaust of brake cylinder pressure will not be restricted.

180. Q.—Why should the K triple valve be removed?

A.—Because if near the head end of the train it may assume restricted release position in which the exhaust of brake cylinder pressure would be unnecessarily retarded.

181. Q.—What should be done if a passenger car is made up in a freight train?

A.—The high speed reducing valve or safety valve should be adjusted to carry about 35 lbs. brake cylinder pressure.

182. Q.—What is this for?

A.—To reduce the percentage of braking ratio of the car.

183. Q.—What is the idea?

A.—To make the retarding force obtained with a full service application of the brake more nearly uniform with that of the freight car brakes.

184. Q.—Why is it not uniform without any special adjustment of the brake cylinder pressure?

A.—Because the service braking ratio of a passenger car is usually based on 90% of its light weight while that of the freight car is based on 60 or 70% of its light weight.

185. Q.—What will be the effect if no change is made when the car is made up in a freight train?

A.—The passenger car will set up a much higher retarding force than a freight car and tend to produce surges in the train and more than likely result in slid flat wheels on the passenger car if a great amount of braking is necessary.

186. Q.—In what way will slid flat wheels be produced?

A.—Through the passenger car being called upon to furnish a much greater retarding effect than the freight cars and must assist in retarding them therefore a surge in the train when the brakes are fully applied may at any time break the adhesion or frictional force obtained between the wheel and the rail of the passenger car and cause the wheels to slide.

187. Q.—What is the difference between a brake test on passenger and freight trains?

A.—None in particular except that the signal system is not used in freight service and that a test of the retaining valve is sometimes specified on freight cars.

188. Q.—At what time is it important to make a retaining valve test?

A.—Just before descending a long heavy grade.

189. Q.—How is a dead locomotive made up in a freight train?

A.—Same as a car but the stop cock in the brake valve branch of the locomotive must be closed.

190. Q.—How is the brake arranged on an engine having the E. T. equipment?

A.—This is usually provided for by engine house employees and whether the brake valve cut out cock is closed depends upon whether the engine has the standard dead engine fixture.

191. Q.—In what position must the brake valve handles be?

A.—In their running position.

192. Q.—How is an engine with the New York L. T. equipment arranged for being hauled in a train dead?

A.—Same as the E. T. equipment, with either one a dead engine feature is used to charge the main reservoir for operating the driver brake, and if this is missing the brake pipe exhaust port of the automatic brake valve can be plugged and the brake valve cut out cock left open and the adjusting nut of the feed valve slacked off to prevent a back flow of air into the brake pipe during a brake application and it is a general practice to set the safety valve or the distributing valve or control, valve to about 30 or 35 lbs.

193. Q.—In making up and testing the brakes on a passenger train, what would be done if engine was coupled up and could not accumulate or maintain the required air pressure?

A.—The train would be inspected for leaks.

194. Q.—Where could the leakage be if none could be found in the brake pipe or in the hose couplings and if all reservoir drain cocks were closed?

A.—A conductor's valve might be open.

195. Q.—What if all are closed?

A.—Go to the pilot of the engine and see whether there is any leakage on the engine or from the brake pipe angle cock on the pilot.

196. Q.—What would be done if no leakage whatever could be found?

A.—Close the angle cock at the rear of the tender and note whether the brake applies. If it applies instantly there must be brake pipe leakage in the train, if it does not, request the Engineer to make an examination of the air compressor and the brakes.

197. Q.—In shifting cars should the conductors valve ever be used?

A.—Only in cases of emergency.

198. Q.—Sometimes a brake fails to release when shifting cars and a quick opening of the conductor's valve will sometimes release it, is this not a good practice?

A.—No, it is likely to result in an emergency application of the brake and a break-in-two of train.

199. Q.—How in a break-in-two?

A.—Emergency application of the brakes originating from the rear of a train or from the opposite direction in which it is moving is liable to stop the rear portion of the train while the forward portion is still in motion and one end of a train in motion with the other end stopped cannot continue but for a very short period of time without the couplings being parted.

200. Q.—What is the object of the back-up hose?

A.—To be attached to the brake pipe hose coupling for operating the brakes in case it becomes necessary when a passenger train is backing into a station.

201. Q.—In how many ways can the brake be applied with this device?

A.—Either in service or emergency or it may be used as a warning whistle.

202. Q.—When is it to be used?

A.—Whenever cars occupied by passengers are being shifted.

203. Q.—Must the brakes be operated with the back-up hose?

A.—No, only in cases of emergency.

204. Q.—Who operates the brakes?

A.—The Engineer as usual on signals from the trainmen.

205. Q.—What kind of signals?

A.—Both communicating and hand signals.

206. Q.—What other times is the back-up hose used?

A.—When cars are being backed in an opposite direction to the line of traffic.

207. Q.—When is the back-up hose then to be used in stopping the train?

A.—If for any reason that the engineer does not respond to the stop signal.

208. Q.—Why is it not generally used for making brake applications?

A.—Because rough stops generally result through the opening, making a reduction that is not uniform throughout the train.

(*To be continued.*)

Electrical Department

Electrical Protective Apparatus—High Direct Current Voltages

In the last three issues we have covered the design and manufacture of the transformer. We have pointed out that the function of the transformer is to transform electrical energy at one voltage to electrical energy at another voltage produced by the electric generators, so as to provide high voltages for transmission of power to long distances, and are used to reduce the high voltage supply to a low voltage suitable for the operation of rotary-converters, motors, lights, etc. The former devices, which increase the voltage, are called "step-up" transformers, the latter "step-down" transformers.

Step-down transformers are located along and at the end of the high voltage transmission lines in sub-stations. Apparatus of some kind is needed to connect and disconnect the high voltage to the transformer. Apparatus is also needed to protect the electrical apparatus from surges and from lightning.

We will consider a sub-station designed for railway service and explain how the power is brought into it, what apparatus is required for the handling of the power and the design and construction of this

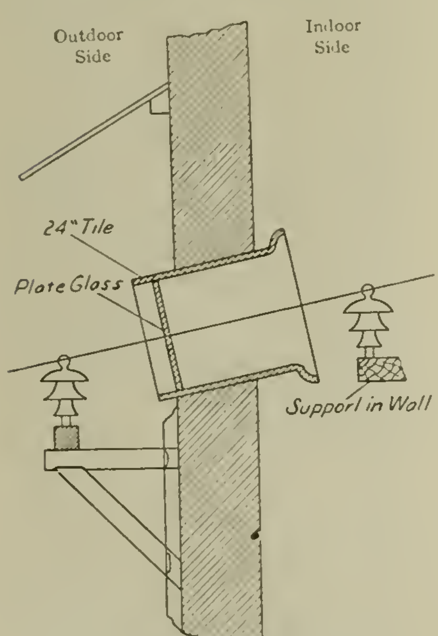


FIG. 1. HIGH TENSION LEADS ENTERING BUILDING.

apparatus. In a later number we will consider the rotary converter, which is the rotary machine that converts the alternating current into direct current for third rail or trolley operation.

The power entering the sub-station is invariably of three phase alternating current. The voltage depends a great deal on the distance which the power is transmitted. It may be 11,000 volts as on the Long Island railroad electrified section, or it may be 60,000 to 100,000 volts, as on some of the Western railways.

Usually all of the electrical apparatus

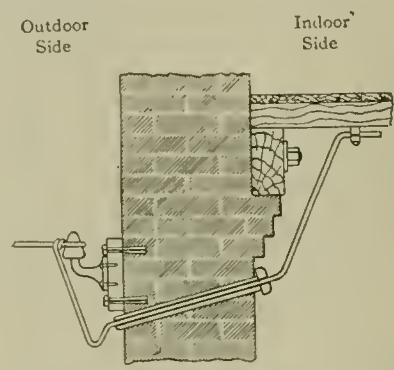


FIG. 2. HIGH TENSION WIRE PASSING THROUGH WALL.

is mounted in the sub-station building, so that the high voltage wires must be brought into the building. There are two general methods used for getting the high voltage through the walls of the building. The arrangement is such that the power will not be grounded and moreover, such that the wind and weather cannot enter.

The arrangements are shown in Fig. 1 and Fig. 2. In the arrangement, as shown by Fig. 1, a tile pipe section is laid in the wall, in one end of which is placed a plate glass partition, provided with a small hole at the center, so as to allow the wire, carrying the current, to pass through. The tile pipe and the wire are slanted, so as to prevent any water, during a rainstorm, traveling along the wire and into the sub-station. To prevent the rain and wind from driving directly against the glass a protecting roof is invariably installed.

The other arrangement is shown by Fig. 2. In it the wire fits closely in a porcelain tube. A loop is made in the wire just before it passes through the tube, so that all water will run to this point and drop off.

After entering the sub-station, the high tension wires are run to disconnecting switches, providing a means for disconnecting the power from all apparatus in the sub-station. From the switches the power is led to the apparatus.

Transmission lines are exposed to lightning. In addition they are subject to surges: alternating current is electricity in the form of waves, and under special conditions the waves may so synchronize with the natural period of vibration of the circuit as to develop a voltage several times the normal voltage and which would become injurious unless dissipated by some form of protective apparatus. Protective apparatus is therefore necessary in the sub-station to keep the lightning and the surges which come in along the wires from damaging the transformers and the rotaries.

The protective devices can be divided into two classes: First, those designed to protect the circuits against overloads of current, and, second, those designed to release the circuits from the electrical stress and strains, due to lightning and voltage surges.

The overload apparatus may be divided into two classes—fuses and automatic circuit breakers. Fuses are used to protect the auxiliary apparatus, so that

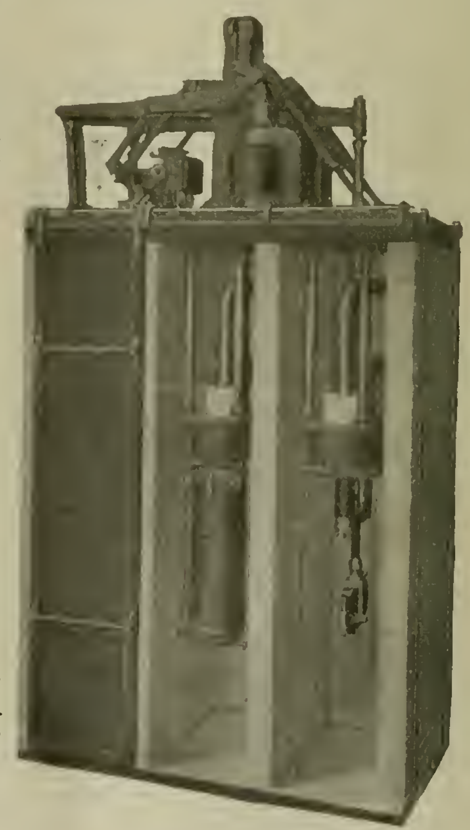


FIG. 3. FRONT VIEW OF CIRCUIT BREAKER

if trouble occurs and the load becomes excessive on that particular piece of apparatus, the fuse will blow, disconnecting the wire from the power. Fuses are well known and hardly need any detail description.

The circuit breaker is used for making

and breaking the high voltage power to the transformers and must be capable of rupturing the arc, which, under ordinary conditions, would be severe. High voltage arcs cannot easily be broken in the atmosphere; they break under oil and the apparatus is called an oil circuit breaker. The construction and operation of an oil breaker is interesting and we will consider this in detail.

For handling the three-phase circuit, each unit circuit breaker consists of three fire-proof brick chambers, in each of which an oil reservoir or oil tank is placed, in these the contacts are immersed. Fig. 3 shows an oil circuit breaker made up of the three compartments as mentioned. The left hand compartment is covered over by a door, which is removable. The middle compartment shows the door removed with the oil tank in position, and the right hand compartment

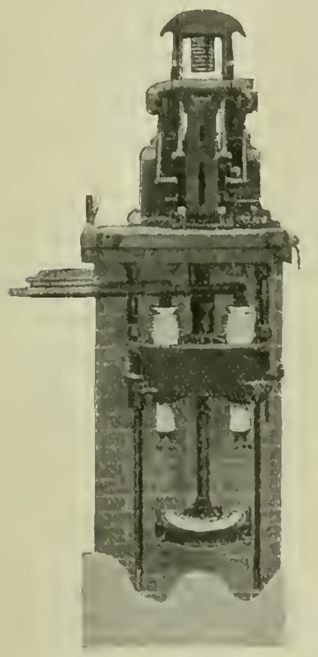


FIG. 4. END VIEW OF CIRCUIT BREAKER OPEN

shows the tank removed with the contacts exposed.

On the top of the brick compartments is shown the operating mechanism. This mechanism controls all poles simultaneously, and is operated by a large magnet coil shown in Fig. 3. The magnet coil pulls the mechanism to closed position and it is held in this position by a latch or toggle. The magnet is energized by closing a small switch usually located on the switch-board which may be several feet away and in other words the breaker is what is called "remote controlled." The breaker can also be opened in a similar manner. At the switch-board, current is connected to a tripping magnet on the breaker which releases the latch or toggle and the breaker opens.

There may be times when high internal pressure exists, so that the tanks are designed to prevent distortion. This high pressure occurs when the breaker opens a severe short circuit. The tanks are elliptical in form and have lap welded joints. A large air space is provided above the oil level to allow for the expansion of the gases which always occur.

When the oil circuit-breaker is opened under load an arc is formed which disintegrates some of the oil, forming a bubble of gas which is carried away by the oil circulation, new and cool oil taking its place. Oil circuit-breakers should be examined periodically, say once a month. This examination consists in taking down the tanks, inspecting and cleaning the contacts and occasionally testing and changing the oil. Sufficient oil must be kept in the tanks and a gauge glass is fitted to the tank so that the proper height may easily and surely be maintained.

High Direct-Current Voltages.

Mention was made in a former issue, of the further electrification of the Chicago, Milwaukee & St. Paul Railroad. The present electrification uses 3,000 volts direct-current, and the same system and voltage will be used for the extension. This reference to the electrification brings up the subject of "voltages." It was only a few years ago that 600 volts was the maximum voltage used for nearly all electric traction purposes. During recent years one of the most important advances in the art of electric railroading has been the adoption of higher voltages.

Higher voltages have progressed along the line of two systems—namely the alternating current and the direct current system. When the limit of 600 volts as a trolley voltage was foreseen, one of the two manufacturing companies (the Westinghouse Co.) brought out the single phase motor and developed the single phase system. The trolley voltage first used was 3,300 alternating current. This voltage was brought up to 6,600, and then to 11,000-12,000 volts, which is now generally used in this country, although abroad 15,000 and even as high as 20,000 volts have been used. After the single phase system had demonstrated the advantages of "high voltage"; the voltage of the direct current system was increased first to 1,200, then to 1,500 and on up to 2,400 and finally to 3,000 volts.

What has been gained by the use of higher voltages, is a question worth answering. The gain has been purely an economical one. In the case of a road, say 200 miles in length, substations are required at intervals to supply electric power to the line and trolley wire and feeders are required to convey this current from the substations to the locomotives. The size of the copper trolley wires and feeders depends on the amount of electric current to be furnished to the locomotives. Let us see what effect the voltage has on this amount of current.

We will assume that an electric locomotive is pulling a heavy train and is developing 1,500 horsepower. There is a definite relation between the electrical unit (kilowatt or 1,000 watts) and the mechanical unit (horsepower). This relation is 1 horsepower $= 746$ watts. The electrical energy required then for the above is $1{,}500 \times 746 = 1{,}119{,}000$ watts. A watt, as we know, is the energy of one ampere at one volt. Therefore if the voltage was 600 volts the amount of current taken by the locomotive would be $\frac{1{,}119{,}000}{600} = 1{,}865$ amperes. If the voltage was 1,200 volts, the current taken would be $\frac{1{,}119{,}000}{1{,}200} = 932.5$ amperes; if 2,400 volts would be 466.3 amperes and if 3,000 volts would be 373 amperes.

Increasing the voltage has, as seen from the above statement, decreased the amount of current for the same power transmitted. The question how does the decrease in current affect the economical side of the electrification is answered by showing that it effects a corresponding decrease in the size of the copper conductors and an increase in the distance between sub-stations; that is fewer sub-stations for the 200 miles. Electric current flowing through a copper conductor meets with resistance, as does water flowing in a pipe, and voltage or pressure is lost. The larger the copper conductor the less the pressure loss. The voltage loss, or drop as it is called, can not be too great, otherwise sufficient voltage or pressure will not be available for satisfactory operation of the locomotive. It naturally follows that the larger the current, the larger must be the copper conductor to carry this current. Therefore with the higher voltage and the lower current the conductor can be brought down in size, and the sub-stations spaced further apart for the same percentage of voltage-drop. The higher voltage makes it possible to electrify long distances, which would be prohibitive on account of the cost if 600 volts were used, due to the immense amount of copper which would be required.

Moreover it may be added that increase in voltage for operation of electric railways, may be looked for in the near future as extensive electrifications using high voltages have already met with much success in various parts of the country.

There is no doubt that the introduction of high voltages has in the past been attended with many difficulties, and the still further extension of high voltages will increase rather than diminish these difficulties, nevertheless it is safe to affirm that high voltages have come to stay, and there is no doubt that many important advantages will yet develop.

Maximum Speed, Retardation and Rail Conditions as Related to Control of Trains

By WALTER V. TURNER, Manager of Engineering, Westinghouse Air Brake Co.

Referring, to a certain extent, to previous articles on the subject of train control, I wish to point out first, that acceleration is the first factor to dictate the maximum speed physically possible on congested districts, and station spacing of trains enters in the way of providing, or failing to provide, first, the period of time during which this speed can be maintained before it is necessary to stop, which influences the speed over a division or rather the average speed. The retardation phase, however, determines what is the safe maximum speed. New brake devices, which give for emergency high retardation rates over those developed for service operation of the brake and electro-pneumatic control, which makes these high rates possible without tearing up the train, have boosted the safe speed to a point which for other reasons railway managers do not care to approach.

In grade service the maximum speed will depend upon the reserve braking force, the heating of the brake shoes and car wheels, and local conditions, such as curvature and change in grade. With the single capacity brake it is necessary to crawl down a mountain grade, because the margin, or braking reserve between control and a runaway train is so small. At low speeds the coefficient of brake shoe friction is high, making a more efficient brake, and the time provided for recharging the brake system, before the increase in speed has taken the brake shoe friction to a greatly reduced value, is prolonged. The empty and load brake, with air consumption reduced one-half and brake effectiveness increased two-and-one-half, or more times, permits materially increased speeds down mountain grades. The braking reserve, increased anywhere from 500 to 1000 per cent more, enables a very short stop to be made at any time during the descent of a grade, where the corresponding stop with a single capacity brake is measured in thousands instead of hundreds of feet. Curves also have an influence on the maximum speed which can be attained or made and slow downs for curves consume both time and energy.

The relation of retardation to the traffic volume handled by the train unit has previously been mentioned in these articles. Retardation depends, of course, on the maximum speed, because the energy to be removed from a moving train in bringing it to a state of rest varies as the square of the speed; that is, as the speed is doubled the stop distance will be multiplied four times, other things remaining equal, or constant.

The energy of a moving car varies directly with the mass or weight therefore, other things being equal, the stop distance will lengthen as the weight is increased. This explains why the hand brake is so inadequate for modern car weights. The brakeman of today is no stronger than the one of yesterday, but car weights have doubled, tripled and even quadrupled. If more effectiveness is sought by increasing the leverage, or by applying hand brakes separately to each truck, the time element for getting brakes into action is greatly increased, which offsets the gain in braking effort. Every second's delay in getting the brakes into action means, at a speed of 60 miles per hour, 88 feet added to the stop distance. To handle the great volumes of compressed air required for modern equipment with the least possible loss of time, requires devices of the most careful and scientific design.

The question of brake shoe duty; uniform braking ratio; number of cars; serial action; air brake equipment necessary for cutting down the time for getting brakes applied and for serial action, and for maintaining a constant braking ratio, whether the car be empty or loaded; a suitably designed foundation brake gear which will avoid, among many others, that evil in the form of low effective retardation due to the attempt to "dribble on" the brakes and avoid shocks, have all been referred to.

When the brakes are applied on a car, each wheel thrusts forward on the rail with a force equal to the brake shoe friction effective on that particular wheel. The equal and opposite thrust of the rail on each wheel or against each wheel, is the force, which, applied from a point external to the wheel, causes retardation. Obviously, if a demand of this sort is made on the rail in excess of the static or rolling friction (generally termed adhesion) between the wheel and the rail, this friction will fail to keep the wheel turning and the brake shoe friction will cause the wheel to slide. The wheel-rail friction now changing, or becoming kinetic in nature, will be very much reduced and the actual retarding force acting on the wheel correspondingly reduced. From this it is evident that the breaking problem must begin and end with the rail. If the condition of the rail surface is bad, which is another way of saying that the coefficient of friction is low, the amount of brake shoe friction that can be used without wheel sliding is very much reduced, and likewise the retardation possible.

As before mentioned, the retardation in percentage (or, what is the same thing, the actual retarding force in relation to the weight of the vehicle) is expressed according to standard nomenclature.

$$R = \frac{p}{C} P\,ef$$

Where the actual cylinder pressure (p) equals the pressure (C) used as a basis for the braking ratio (P), this expression is simplified thus,

$$R = P\,ef$$

Now if A be the designation for the adhesion, or coefficient of rolling friction between the wheel, and the rail, the critical point for wheel sliding will be when the retarding force equals the adhesion; that is,

$$P\,ef = A$$

The actual value of the adhesion A will vary from 12 to 30 per cent depending upon weather conditions of temperature and relative humidity. With sand on the rail it may run even higher than 30 per cent. Taking an efficiency factor of 8 per cent, and an adhesion value of 25 per cent (which is representative of the usual conditions of rail surfaces) the braking ratio (P) necessary to slide wheels is,

$$P = \frac{A}{ef} = \frac{.25}{.08} = 312.5 \text{ per cent}$$

On the other hand if the adhesion drops to 12 per cent, due to uncontrollable weather conditions, the braking ratio necessary to slide wheels is only,

$$P = \frac{.12}{.08} = 150 \text{ per cent}$$

If in the latter case the efficiency factor be 24 per cent, the braking ratio need be but 50 per cent to cause wheel sliding. Thus it is appreciated that the dependence of the whole problem of braking becomes not as popularly believed, upon the question of braking ratio alone, but upon the values of wheel-rail and shoe-wheel friction as well, for here we have illustrations of wheel sliding with braking ratios varying from 50 to 300 per cent.

The difference between a train in motion and one at rest is one of kinetic energy content. In order to bring a moving train to rest it is necessary to remove this energy, and until recently the only available means was to cause it to flow from the train through the brake shoes in the form of heat energy and to be dissipated and lost in the surrounding atmosphere.

The energy content of a modern train, due to greatly increased mass and velocity, is such that, could it be properly harnessed and directed, it would carry a full load of an 8000-kilowatt power plant for one minute's time. Any means then for saving this energy for use in accelerating trains is an economy of vital importance. Electric operation of trains provides an opportunity for effecting this saving in that a suitable motor control apparatus can direct the driving effect of the moving train to operate the motors as generators and return thereby the kinetic energy of the train to the line in the shape of electrical energy. This is regenerative braking. In addition to the energy saved, wear and tear on the car wheels and brake shoes is avoided.

However contrary to the expectations of the uninitiated, the need for modern air brake installations is just as pressing with regenerative braking as without it, for otherwise, in the event of any failure in the line or in the motor equipment, the train would be altogether uncontrolled. Moreover, where regenerative braking is employed with the electric locomotive, the responsibility for control is vested in one or two units, and a failure of one or both means a failure of half or of all the power to control. On the other hand, with an air brake equipment on every car in the train, a failure of one, two, six or ten units (depending upon the total number in the train), will be of relative insignificance.

Thus it is of apparent significance, that to realize the best economies in the control of freight trains down mountain grades with the regenerative braking it will be necessary to employ the empty and load brake in order to provide the braking reserve indispensable to speed and safety, otherwise if the single capacity brake is employed and the safe speed for this type of brake is exceeded at any time during regeneration, a failure of the regenerative brake means the runaway of the train. This subject of regenerative braking is worthy of a volume in itself and will again be referred to in these columns.

Horse Power and Tractive Effort.

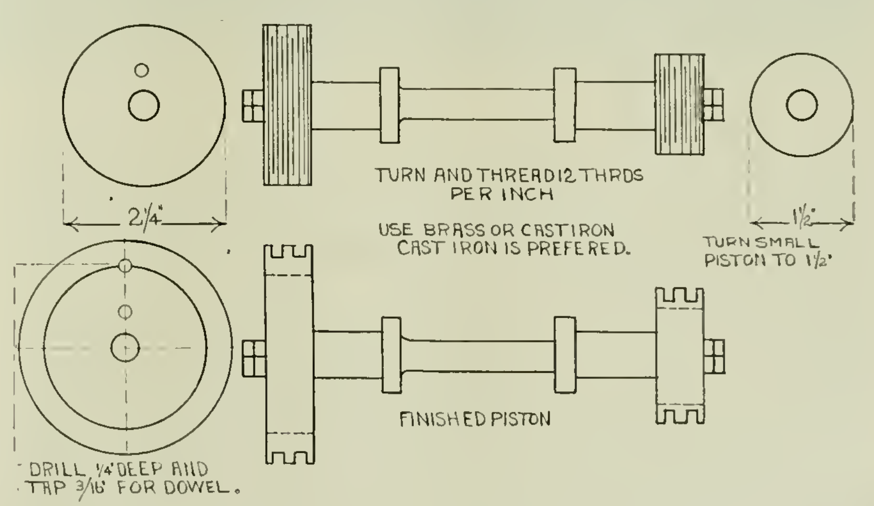
By C. Richardson, Bridgeport, Conn.

The article in the December issue of Railway and Locomotive Engineering in regard to horsepower and tractive effort was illuminating as far as it went, but to my mind it did not quite go to the root of the matter. Mere formulas are not very satisfactory to the young looking after facts. The question naturally arises—how was the formula obtained? In venturing an illustration it is not necessary to dwell on the 85 per cent of the allowable boiler pressure, it is so generally accepted as being about all that is available in steam engine practice. Coming to the means of obtaining the tractive effort of a locomotive, assuming that the diameter of the piston is 26½ in., then the area of the piston is 552 in., and supposing the steam pressure is 180 lbs., 85 per cent of which equals 153. Hence this amount multiplied by 552 equals 84,456 lbs. This pressure acting through one stroke, 30 in., gives 2,533,680 inch pounds; but while the driving wheels make one revolution, the pistons make four strokes on each side of the locomotive, so the total inch pounds developed during one revolution of the drivers is 4 x 2,538,680 inch pounds, or 10,134,720 inch pounds, and this total power developed is transferred into a horizontal drawbar pull over a distance equal to the circumference of the driving wheels. The diameter of the driving wheels, say 63 ins., the circumference would be 198 ins. Dividing the total 10,134,720 by 198 gives 51,185 lbs. as the tractive effort or drawbar pull. If a locomotive of these dimensions and pressure could maintain this pull at 35 miles per hour, it would develop about 3,500 horsepower.

Reclaiming Main Valve Pistons for 9½-inch Pumps.

By J. H. Hahn, Bluefield, W. Va.

The present high price of material justifies the reclaiming or repairing of any part of the mechanical appliances used on railways, more particularly if the repair is as good as a renewal. The drawing we reproduce shows in detail a method of reclaiming the main valve pistons of the 9½-in. pumps. The main



valve bush 31,251 is first bored out, a special boring bar described and illustrated in Railway and Locomotive Engineering some time ago being well adapted for the purpose. The left main valve cylinder head 5,166 is bored in the lathe, keeping the size of the same in the necessary proportion to the main valve bush. The pistons are then finished according to the drawing and turned to the proper sizes for their respective bushings, and after fitting the rings and assembling the parts the job is completed, and will be found as serviceable as new pistons, the cost being more than 50 per cent. less than the cost of complete new pistons, not to speak of the so called unavoidable delay eliminated in having orders for new material promptly filled in these strenuous times.

Loose Pulleys Scratch Shafts.

A writer in one of the English Technical publications, calls attention to a very simple way of preventing the scratching of shafting by loose pulleys. For some reason, unless special care is taken, loose pulleys badly score the shafting at both sides of the pulley. The fit of the pulley apparently has not very much to do with the matter. It may be reasonably assumed, and it is backed by experience, that there is little danger of the shafting being broken by the scoring of the shaft but it causes inconvenience in other ways, to say nothing of the bad appearance. By rounding off the edges of the bore of the pulley, the scoring is prevented, and this should always be done with loose pulleys, especially on fast running shafts. Additional work is caused from time to time by rows of dirt collecting, and then the collar has to be taken off and the shafting scraped clean. Preferentially, loose pulleys should be run on bushes were the extra cost is not too great a consideration.—*Practical Engineer.*

A Call for Food Saving.

The United States Food Administrator is urging upon all editors to call particular attention to the fact that the American people eat much more than is necessary to maintain health. Some of the figures furnished are startling, but they are beyond controversy. The hoarding of food is also strongly condemned. The question is one that seriously adds to the demand upon our railways for cars because of our military demands, as it is with extreme difficulty that we can now move the vitally necessary food to the markets.

Performance of the Mohawk or 4-8-2 Locomotive of the New York Central Railroad

Good Tractive Effort Maintained at High Speed—The Variable Factor—Good Points of Satisfactory Types—Builders and Designers Work In Harmony

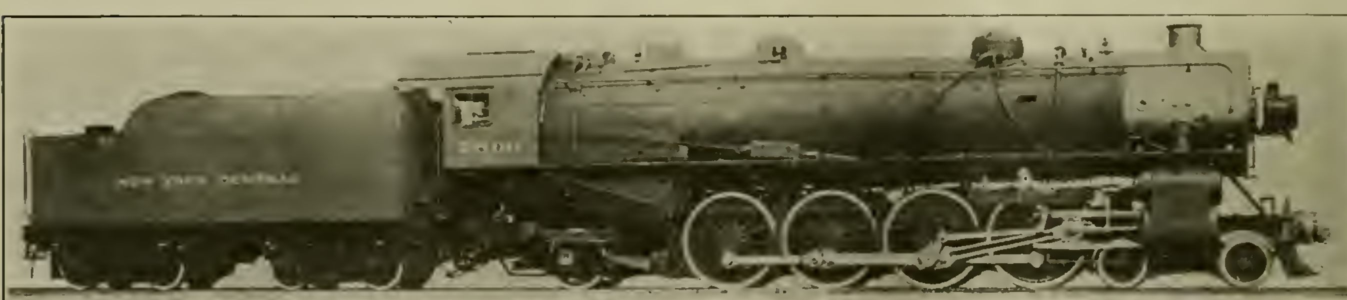
The Mohawk 4-8-2 engines which have been used on the division of the New York Central Railroad, which takes its name from the beautiful valley along the river of the same name, were built by the American Locomotive Company in the months from July to December, 1916. These engines are of the following dimensions: Cylinders, diameter 28 ins., and stroke 28 ins.; driving wheel, diameter 69 ins.; boiler, diameter 80 ins.; steam pressure, 190 lbs.; firebox, length 114¼ ins.; firebox, width 84¼ ins.; tubes (small), dia. 216, 2¼ x 21 ft. 6 ins.; tubes (large), 45, 5½ x 21 ft. 6 ins. Wheel base, driving 18 ft. 0 ins.; engine 38 ft. 11 ins.; engine and tender, 72 ft. 9 ins.; water capacity, 8,000 gallons; maximum tractive power, 50,000 lbs.; weight in working order, on leading truck 52,500 lbs.; weight in working order of engine 234,000 lbs.; weight on trailing truck, 56,500 lbs.; total engine, 343,000 lbs.; weight in working order of tender, 166,500 lbs.; heating surfaces, tubes, 2,723 sq. ft.; flues, 1,387 sq. ft.; firebox, 292 sq. ft.; arch tubes, 28 sq. ft.; heating surface, total 4,430 sq. ft.; superheater, 1,212 sq. ft.; grate area, 66.8 sq. ft.; factor of adhesion, 4.68; coal capacity, 14 tons.

The tonnage hauled by these engines is comparable with that hauled by other engines developing the same starting or initial tractive effort, but this type of engine is able to handle these tonnages at higher rates of speed, because their tractive effort is better sustained at higher speeds than is the case with the freight engines heretofore used. These engines have been able to show a decrease in the time required for the handling of heavy slow freight trains. They have been handling fast freight trains of 2,500 to 3,500 tons, or from 75 to 95 cars over the Mohawk Division (140 miles) in from five to eight hours.

The Mohawk Division is essentially a descending grade from west to east along the Mohawk River; the short grades in that direction do not exceed .5 per cent, except the low grade line near Schenectady, which is approximately eight miles long, of very nearly uniform grade and not exceeding .27 per cent. Westbound grades are generally ascending and do not exceed .5 per cent.

So far as special appliances are concerned, there are few upon this type, of any particular interest. The engine is equipped with a superheater, the dome is of pressed steel formed in one piece, the fire box is equipped with the Security brick arch, the engine has a 40-in. combustion chamber and 21 ft. 6 in. flues. The main driving boxes are 18 ins. long, whereas other driving boxes are 13 ins. long. The main pedestal jaws are widened by the use of steel castings bolted against the inside face of the frame pedestals. These castings also perform the function of frame crossties. The throttle valve is the balanced outside dome connection type.

This type of engine was designed to meet specific conditions of speed and tractive effort requirements, and the New York Central Railroad are just now receiving from the American Locomotive Company a second large lot of this type of engine.



MOHAWK 4-8-2 ON THE NEW YORK CENTRAL.

John Howard, Superintendent Motive Power. American Locomotive Co., Builders.

Wood and Steel Car Construction.

In an interesting paper with the above caption read before the members of the Car Foremen's Association of Chicago a short time ago by Mr. H. S. Sackett, timber engineer, Chicago, Milwaukee & St. Paul Railway, a careful comparison was made between the records of the steel car and the wooden car, and an analysis of the causes that led to the introduction of the steel equipment. Briefly summarized, the chief causes were the burning of wooden cars in wrecks, the splintering of sills in collisions, the scarcity of timber, the danger from electricity and the demand for fireproofing material where possible. There was also a demand for increased speed, greater train length, and larger car capacity. Mr. Sackett claimed that steel cars have also a fire hazard, as it is the contents and not the car itself that carries the danger. The other points were debatable. Why wooden sills should be more harmful and dangerous than steel ones is not clear. The greatest danger when collisions occur, is caused by the telescoping of the cars, that is, the floor level of one car rising above that of the next, and the impact shoving the one into the other. No matter whether the cars are of steel super-structure or wooden, the telescoping takes place just the same, and probably to a more serious degree in the longer steel trains on account of their enormous weight. Even in the case of the all-wood car, the understructure is so much more substantially built than the super-structure, that telescoping is bound to take place no matter whether the train contain cars of all-wood construction or of steel and wood mixed. It might be well at this time to state that there are three general types of car construction—all-wood, all-steel, and steel underframe with wood superstructure.

As to the supply of timber, the latest available records of the Government showed that at the present enormous rate of consumption, not considering new growth, there was sufficient to last for 60 years. It is selling for little more than it cost ten years ago, whereas steel has increased enormously in price and is difficult to secure. Steel cars have made possible greater length of trains, but it is doubtful if they have also enabled trains to increase in speed. They have made

necessary an increase in motive power, and an increase in the size and weight of the rails.

The two factors of paramount importance to the passenger are comfort and safety. There seems but little use of discussing the advantages of the wooden car from the standpoint of comfort, as almost any traveler will testify that the wooden cars are warmer in winter and cooler in summer; that they are less noisy; that they are easier riding, being more pliable and less stiff than the steel car; and last but not least, that they are eminently more pleasing to the eye. The effort on the part of the steel car manufacturers to imitate wood has not given the results that they may have expected. The ubiquitous "redness" of the Pullman cars has become monotonous to every traveler, and it has been noted recently, with a great deal of satisfaction, that this imitation mahogany color is giving way to some soft grays and browns, which greatly improve the appearance of the cars.

In spite of the ten years' propaganda for steel passenger cars, however, there were in service last year in the United States, 41,382 all-wood cars, 14,286 all-steel, and 6,060 cars with steel underframe and wooden superstructure—nearly twice as many all-wood cars as all-steel and steel underframe combined.

In summing up, Mr. Sackett stated that from the data which has been available, it is evident that for many reasons the public is inclined to favor the wooden passenger car and sleeper, that is, a car with a steel underframe and steel skeleton superstructure insulated with wood. The only point in which the public would seem to prefer the car of all-steel construction is in its "supposed" greater safety. As has been stated, however, it is felt that this measure of safety depends to a considerable extent upon the size of the train, the speed at which it is run, and the motive power used to haul it.

From the standpoint of the railroad it has been fully demonstrated that the steel equipment costs more originally, costs more to maintain and repair, has the indications of a shorter life, and on account of the excessive weight costs more to operate than the wooden equipment. The only other question to be answered in this connection is, does it earn more than the wooden car? Such information has been impossible to secure, and it is doubtful if any of the railroad companies have compiled definite information on this point. Certainly, however, it is a subject worthy of investigation.

A very lively debate followed the reading of Mr. Sackett's paper, some of the most important points being the facts that in 1909 of all the passenger cars built 26 per cent were of steel. 22.6 per cent were of wood with steel underframes, and 51.4 per cent were all wood. In 1916 about 91 per cent of the passenger cars were of steel, 7 per cent were of wood with steel underframes, and only 2 per cent of wood.

Engineman Becoming Motorman

A certain amount of uncertainty, not to say fear, existed in the minds of many persons when the electrification of parts of our large trunk lines came to be a practical question. As soon as electric locomotives got to work all objection by the crews regarding heavy trains came to an end, as it makes no difference whether the men have forty or a hundred cars in the train. Under steam operation the locomotives may be changed every division. But when the motors stay with a train for at least two divisions and change at an intermediate division point, the running time over the old divisions may be shortened, and so the crews often look favourably on motors.

At one time many of the train men were sceptical about their chances in case of a wreck if the trolley wire fell down and killed the train crew and left the train to run wild. This condition looks impossible to the electrical engineer, but it is not easy to remove it from the minds of men who have never had any experience with electricity. The old operatives are preferable to men who have had a little experience with low-voltage circuits, enough to make them foolhardy with higher voltage. The steam men know nothing about electricity; they admit it and are ready to take to precautions before handling any electric apparatus whether energised or not.

It was difficult for enginemen of steam locomotives to realize how important the trolley wire and the pantagraphs were, until they had an accident or two involving these equipments. In the early stage they were intent on the operation of the locomotive only, and if they were (by a careless or negligent switchman) headed into a track which had no trolley wire it was quite likely that they would take the signal and go into it only to discover that they had a dead motor and could not get back to the wire again, or the pantagraph had been caught and smashed against the overhead wires or other obstructions.

Men have been instructed never to go on top of the locomotives or to open any covers over electrical apparatus with either of the pantagraph current collectors up against the wire. Each locomotive is equipped with a long pole hook and dry rope which can be used to pull a pantagraph from a wire. Since there are two pantagraphs on each machine, it is comparatively easy to disconnect one if it is damaged and to make use of the other one.

Operating men regard the whole arrangement of electrification as a success. Shorter working hours, the cleanliness of the surroundings of work, little on the locomotive requiring close attention, less danger involved, no anxiety about coal and water, and confidence in the equipment by knowledge of its operating details, have won many friends to the electric locomotives from among the men who use them.

Instruction work was comparatively easy. The men would talk over the new machines, and their various experiences with each particular feature were discussed by them, so that much instruction work was briefly passed over. And the men after being out on the road were willing to drop in and become acquainted with the motor blue-print wiring diagrams, and learn just what details were necessarily required.

Passenger crews on a line in England which had been partly electrified were given more work in learning than the freight men, since on through-runs there was little opportunity to show up the fine points. These men usually had half-a-day off every other day, and came to the round-house, where an instructor would purposely remove fuses on a spare locomotive, put match stems in the relays, and cause a multitude of troubles for the engine men to find and remedy.

The technical terms used by electrical engineers for apparatus and electrical quantities were readily taken up by the steam men where they were not confusing or where one term for a thing is strictly adhered to.

This account, although noticed in England is largely drawn from the writings of Mr. W. F. Coors of the General Electric Company. He has had much experience of the process of changing men from being engine men on steam trains to drivers of electric trains. Some English railway companies which have converted parts of their lines from steam to electric traction have had similar experience, but generally in their case multiple-unit electric trains are used instead of electric locomotives.

Order to Supply Coal

Orders relative to providing an adequate supply of bituminous coal to four of the large railroads of the country have been issued by Harry A. Garfield, United States Fuel Administrator. The roads for which this action was taken are the Pere Marquette, Seaboard Air Line, Atlantic Coast Line, and the Norfolk Southern. The orders follow the general policy of the Fuel Administration in assuring a coal supply for all railroad companies.

Latest Design of Reversing Planer-Motor Equipment.

Among machines equipped with an electric drive there are probably none meeting with more general favor wherever they have been established than the Westinghouse planer-motor, designed to operate such machines as planers, draw-cut shapers, slotters and gear planers. These tools are used in practically all machine shops, and especially by machinery builders, railroad shops, and by locomotive and car builders.

The equipment particularly adapted for planers consists of a special commutating-pole motor, and a controller, which is operated automatically by the movement of the driven machine. The motor is direct-connected to the planer and reverses with each stroke, so that belts, tight and loose pulleys, and countershafts are eliminated. The equipment as now perfected is the development of much careful experiment, and forms a positive, economical and highly efficient drive. The cutting and return speeds can be readily adjusted, independently of each other, so that the most economical speed can be used to give the maximum production for any length of stroke, depth of cut, or weight of platen, either heavily or lightly loaded.

The design embraces the quality of low flywheel effect and quick reversing. In point of durability the maximum degree of economy may be said to have been reached. The complete absence of sparking assures long life for the commutator and brushes. In regard to the armature, it may be stated that in any service requiring quick starting and stopping the flywheel effect of the armature is an important factor. As the armature is accelerated to full speed, energy is stored up and a momentum obtained which must be overcome when the motor is stopped, and as the flywheel effect increases with the square of the armature diameter, it is evident that the relatively small diameter of the armatures used in this class of motors are particularly adapted for quick starting, stopping and reversing with relatively low current consumption.

Our illustration shows the compact design of the planer motor. Of the control it may be said briefly that it consists of a controller, a master switch, and a pendant switch. The master switch is mounted on the planer bed, and is operated by a tripping mechanism attached to the platen, and furnished by the builder of the machine. When it is tripped, the motor starts, and it is automatically accelerated to the desired speed; at the end of the stroke, the master switch is tripped again, and the motor is stopped by the dynamic braking, and is immediately started in the reverse direction.

35-H.P. REVERSING MOTOR FOR PLANER SERVICE.

Of the materials, it would be a mere reiteration of what has frequently appeared in our pages in regard to the work of the engineering department of the Westinghouse Electric and Manufacturing Company. The latest improvements in alloy steels and other metals are taken admirable advantage of, so that there is a degree of lightness in these powerful motors which in contrast to the horse-power developed is amazing.

Journal Box and Train Pipe Hanger and Clamp.

The National Oiled Spring Journal Box is a marked improvement in journal boxes. Apart from the material, which is malleable iron, the design is the result of much practical experience, embracing as it does a safeguard from the inevitable wear from the pedestals and equalizer by the use of hard steel inserts cast into the pedestal guides and equalizer seats which insure lasting wearing qualities. Another marked improvement consists of a new design of the lid or cover. As is well known this part of the journal box should be so constructed as to prevent dust from entering the box when closed and also prevent the oil from leaking out. As shown in our several illustrations there is a spring lever pivoted to the inside face of the lid which receives the thrust from a coiled spring seated in a pocket in the lid, and transforms the pressure of the spring by fulcruming against the hinge lug into a powerful direct inward pull against the center of the lid at right angles to it and the mouth of the box when the lid is closed. The pressure of the spring is such that it completely prevents the wear of parts through vibration of the truck while in motion. The box is applicable to all trucks now in general use either of the M. C. B. arch bar or special types for all standard sizes of journals. This new type of journal box is manufactured by the National Malleable Castings Company, Cleveland, Ohio.

The same enterprising firm has also placed on the market an ingenious but simple device for fastening the air brake pipe to the car framing. As shown in our illustration it consists of a hanger and clamp. It is also made of malleable iron which, on account of its rust-resisting properties and ability to withstand shocks, makes it extremely durable and strong, and is especially adapted for use on refrigerator and stock cars, where the ordinary iron strap hanger soon rusts out, and becomes unfit for use. As is shown only one bolt is necessary to clamp the pipe. An interlocking, pinless hinge facilitates the work of installing the air brake pipe, but is so designed that should the bolt drop out while the car is in transit, the parts will not become separated and lost. The clamp may be made with any length of shank to suit the requirements.

IMPROVED JOURNAL BOX.

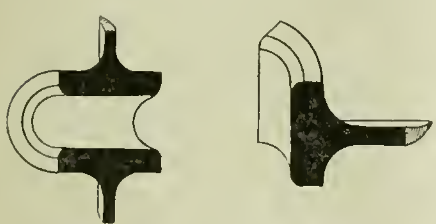
TRAIN PIPE HANGER AND CLAMP

Bushings Advantageous on Shafts.

In continually using shafting it is not unusual to find that spare pulleys accumulate in the shop or store room, in the course of years. It is not unusual to find that in the collection of spare pulleys, some of suitable diameter for some particular job, but with wrong bores for the shafting to pass through. If the hole

BUSHING SHOWING KEYWAY.

is too small, and the wheel boss has sufficient substance, re-boring to the right size can be managed, and a fresh keyway cut, but where the hole is too large a bush must be made and a new key fitted. The thickness of the bush depends on what reduction of size is to be made. Time may be an important factor, and the bush may be either cast or wrought iron, as may be convenient. It should



BUSH IN CENTRE OF PULLEY.

be turned up true both inside and out, and should be a tight fit for both pulley and shaft, and a piece should be cut out to form an extension of the keyway in the pulley. The keys used would have to be thicker by the thickness of the bush than in ordinary cases, otherwise a practically useless bit of work would have been done.—*Practical Engineer.*

The Transportation Unit.

What has been called the "Transportation Unit" consists of the car to carry the load. A locomotive to move that load. The track upon which the train runs, and the automatic signal to direct the movement of the train. Car, engine, track and signal thus become, in a sense, the Unit of Transportation. In England a new road is not opened for business or permitted by government to operate until it has been inspected by a representative of the Board of Trade (a government department), and has been found to be fully equipped with a thoroughly satisfactory signal system, in good working order. Why this is not the case here has not been satisfactorily explained. Time was when there may have been an excuse, but today an adequate reason is wanting.

The signal system in England is not considered as an auxiliary, or a sort of transportation frill. It is regarded as a vital necessity, just as much a part of the railroad as the track it is considered indispensable. Without it, a company can not do business. Our system as it stands with a signal system left as a voluntary idea, puts England in the lead as far as this matter goes. A short time ago one of the New York daily papers pointed out a fact in a railroad news item. It was, that to release motive power, conserve fuel and reduce railroad congestion, one of our large railways recently withdrew from its New York service, eight passenger trains, four in each direction. Several local trains were also annulled, and it was announced that a further curtailment in local service would become effective early in January, 1918. A reduction in the numebr of parlor cars attached to trains operating between New York and Washington equal to eight trains has been put into effect by another system. The restrictions, it is estimated, will enable the railroads to increase freight movement by about 40,000 tons daily. This means that eight passenger trains taken off, make way, each, for 5,000 tons. Such an addition (5,000 tons every day), for a month of 30 days, aggregates 150,000 tons. This is worth while doing in these days, now the war is on. It is only stating a truism to say the car should carry the maximum load. The locomotive should pull the maximum train. But unless the means for directing the train movement is efficient, a large part of the gain due to the maximum load of the car and the tractive power of the locomotive is lost. Block and interlocking signals protect the value of the investment in cars and locomotives and increase their utility through efficient direction of train movements, as nothing else can, and they help to save life when properly obeyed, as they must be.

On a single track road a fast passenger trains owns the track ahead of it for 5 minutes and for 10 minutes behind it. If the train is going 60 miles an hour, there are 15 miles of good track preempted to keep this train safe. It is necessary and it must be done. Now if a double track road is properly signaled, no matter what the speed the train runs at, it just owns the track ahead of it up to the first signal in front, and back to the signal behind it. That is usually a good deal less than 15 miles. The following train may go ahead when the home signal arm drops and it is at the same time warned that the passenger train is in the next block ahead. By means of these signal "directions" a train can sooner begin to follow a fast passenger train with perfect safety if the signals are implicitly obeyed, as they must be, and thus the freight train gets over the road in a shorter time than if no signals were in use on the line.

With 5,000 tons daily increase in haulage, and the time on the road shortened safely enough, for freight, it looks as if a very substantial piece of transportation work was in sight, and a safe and expeditious solution had been hit upon. The discipline may not be all that could be desired, but if the men on the road are told and shown how it helps the work of the railway, that it is an old rule with a fuller meaning, and above all that it is a safe and really patriotic thing to play the game squarely, they will respond in a full and loyal way, and the vagaries and uncertainties of the "chancetaker" will be things of the past for good and all.

A. R. E. A. Officers.

The following have been nominated for officers of the American Railway Engineering Association for 1918: President, C. A. Morse, chief engineer, Chicago, Rock Island & Pacific, Chicago; vice-president, H. R. Safford, chief engineer, Grand Trunk, Montreal, Canada; treasurer, Geo. H. Bremner, district engineer, Division of Valuation, Interstate Commerce Commission, Chicago; Secretary, E. H. Fritch, Chicago.

Appeal to Railway Men

In an appeal to the employees of the Lehigh Valley, E. E. Loomis, the president says: "There must be no slackers among us. Every man must stick to his job in these troublesome days. It is a time for self-sacrifice. This means working thirty days a month, if necesary, regardless of weather conditions; losing no time after pay day; assisting, each in his place, in running this railroad at the highest point of efficiency. I call upon you all to enlist heart and soul in this patriotic service."

New Agency for the White American Locomotive Sander Company.

In addition to the railway specialties already represented by Oscar F. Ostby, 2736 Grand Central Terminal, New York, he has been appointed sales representative of the White American Locomotive Sander Company, Roanoke, Va., for territory from Baltimore north to the Canadian border, and west as far as Pittsburgh and Cleveland.

Big Wind.

The *Popular Science Monthly* assures its readers that there is a stretch of railway along the west coast of Ireland where it is not uncommon for the trains to be blown off the rails by the wind. Movable ballast is said to be placed on the cars to increase their adhesion during these stormy periods.

Items of Personal Interest

Mr. J. W. Coulter has been appointed master mechanic of the Alton & Southern, with office at East St. Louis, Ill.

Mr. J. A. Delaney, formerly master mechanic of the Rio Grande division of the Texas & Pacific, at Alexandria, La., has been transferred to Big Spring, Tex.

Mr. W. W. Lemon has been appointed superintendent of the motive power and car departments of the Denver & Rio Grande, with headquarters at Denver, Colo.

Mr. W. D. Hitchcock has been appointed master mechanic of the Albuquerque division of the Atchison, Topeka & Santa Fe, with office at Winslow, Ariz.

Mr. B. Gamble, formerly roundhouse foreman of the Gulf, Mobile & Northern, has been appointed roundhouse foreman of the St. Louis-San Francisco, with office at Sapulpa, Okla.

Mr. W. B. Whitsitt, formerly shop engineer in the drawing room of the Mount Clare shops of the Baltimore & Ohio, Baltimore, Md., has been appointed chief draughtsman.

Mr. James E. Manzell, formerly shop motor maintainer on the New York, Ontario & Western, has been appointed to the position of electrical foreman, with office at Middletown, N. Y.

Mr. L. W. Hendricks, formerly master mechanic of the New York, New Haven & Hartford, has been appointed superintendent of shops at Van Nest, N. Y., succeeding Mr. J. L. Crouse, resigned.

Mr. L. L. Allen, formerly general foreman of the St. Louis, Brownsville & Mexico, at Kingsville, Tex., has been appointed master mechanic of the Gulf Coast Lines, with office at De Quincy, La.

Mr. W. H. Keller, formerly master mechanic of the Texas & Pacific at Big Spring, Tex., has been transferred to the Ft. Worth division, with office at Ft. Worth, Tex., succeeding Mr. G. W. Deats.

Mr. E. S. Pardee has been appointed mechanical engineer of the Cleveland, Cincinnati, Chicago & St. Louis, with headquarters at Beech Grove, Ind., succeeding Mr. W. E. Ricketson, promoted.

Mr. C. F. Ludington, formerly superintendent of the fuel department of the Missouri, Kansas & Texas, has been appointed fuel supervisor of the Chicago, Milwaukee & St. Paul, with office in Chicago, Ill.

Mr. C. F. Lingenfelter has been appointed assistant road foreman of engines of the Pittsburgh division of the Pennsylvania, with headquarters at Conemaugh, Pa., succeeding Mr. S. G. Glassburn, transferred.

Mr. W. R. Harrison has been appointed master mechanic of the Southern Kansas division of the Atchison, Topeka & Santa Fe, with office at Chanute, Kans., succeeding Mr. W. H. Hamilton, assigned to other duties.

Mr. C. E. Peck, formerly general foreman of the Southern Pacific at Roseville, Cal., has been appointed master mechanic of the Portland division, with office at Portland, Ore., succeeding Mr. George Wild, resigned.

Mr. M. Turton has been appointed mechanical superintendent of the International Railways of Central America, with office at Guatemala City, Guat., succeeding Mr. R. Potts, resigned, to accept service with another road.

Mr. C. A. Wirth has been appointed master mechanic of the Pasco division of the Northern Pacific, with office at Pasco, Wash., succeeding Mr. G. F. Egbers, who has been granted leave of absence to enter the Russian Railway Service Corps.

Mr. G. F. Wieseckel, formerly master mechanic of the Western Maryland, with office in Hagerstown, Md., has been appointed superintendent of motive power, with office at Hagerstown, succeeding Mr. R. Warnock, resigned.

Mr. R. L. Browne has been associated with the sales department of the Goldschmidt Thermit Company, N. Y., as commercial engineer. Mr. Browne has had a thorough course of training in the Thermit welding process, and is among the leading experts in the trade.

Mr. T. S. Davey, formerly shop superintendent of the Erie at Buffalo, N. Y., car shops, has been appointed master mechanic in charge of engine terminals at Croxton, N. J., and Mr. L. C. Fitzgerald, formerly car foreman, succeeds Mr. Davey.

Mr. William H. Fetner, formerly acting superintendent of motive power of the Central of Georgia, has been appointed superintendent of motive power, succeeding Mr. F. F. Gaines, who on account of continued impaired health has been assigned to other duties.

Mr. H. R. Warnock, formerly superintendent of motive power of the Western Maryland at Hagerstown, Md., has been appointed general superintendent of motive power of the Chicago, Milwaukee & St. Paul, with headquarters at Chicago, Ill., succeeding Mr. A. E. Manchester, deceased.

Mr. N. B. Payne, electric crane specialist, dealing in new and second hand traveling cranes, has opened an office at 25 Church street, New York Mr. Payne has had a wide experience in this class of work, and was formerly employed with Manning, Maxwell & Moore, Inc., New York.

Mr. H. Clewer has been appointed superintendent of Fuel Economy of the Chicago, Rock Island & Pacific with headquarters at Chicago, Ill. Mr. Clewer has appointed assistants at the chief division points of the road, and systematic methods of instruction in economy and efficiency are being placed in operation.

Mr. R. N. Nichols, formerly general foreman of the Central of New Jersey at Communipaw engine terminal, Jersey City, has been appointed assistant master mechanic, and Mr. W. E. Hardy, formerly at East Twenty-second street, has been promoted to general foreman at Communipaw, succeeding Mr. Nichols.

Mr. C. E. McAuliffe, formerly master mechanic of the Missouri Pacific, at Atchison, Kans., has been transferred to Wichita, Kans., succeeding Mr. R. H. Tait, transferred to Kansas City as master mechanic. Mr. F. Rauber has been appointed division foreman at Wichita, and Mr. Samuel W. Ashford has been appointed master mechanic of the White River division.

Mr. J. W. White has been appointed manager of the power and railway divisions of the Detroit office of the Westinghouse Electric & Mfg. Company. Mr. White was formerly connected with the Pittsburgh office of this company, subsequently becoming associated with the Allis Chalmers Company, and has now returned to the Westinghouse Company, assuming the position above noted.

Mr. J. H. Pardee, president, and Mr. J. P. Ripley, railway engineer, of the J. G. White Management Corporation, New York City, have been visiting the Philippine Islands, making a general inspection of the Manila Electric Railroad and Light Company, and other interests in the islands operated by the management corporation. They are expected to return to New York before the end of January.

Mr. Leonard S. Cairns, formerly assistant general manager of the Manila Electric Railroad and Light Company, Manila, P. I., has been appointed general manager of the Eastern Pennsylvania Railroad Company, with office at Pottsville, Pa. The White Management Corporation, New York City, are the operating managers of both companies. He succeeds Mr. L. H. Palmer, who recently became assistant to the president of the United Railways and Electric Company, Baltimore, Md.

Mr. D. G. Cunningham, formerly assistant superintendent of motive power of the Denver & Rio Grande, has been appointed superintendent of motive power. Mr. Cunningham is a graduate of the Virginia Polytechnic Institute and entered as machinist's apprentice in the Norfolk &

Western Shops at Roanoke, Va., in 1890. Latterly he has had experience in several western roads and was for several years superintendent of shops of the Denver & Rio Grande at Salt Lake City, Utah.

Mr. D. O. Leary, master mechanic of the Pacific Coast railroad since 1893 and also master mechanic of the Pacific Coast Steam Ship Company's repair works, has resigned to accept a position as machinery inspector with the United States Shipping Board Emergency Fleet Corporation. Mr. Leary is a member of the American Society of Mechanical Engineers, and the American Railway Master Mechanics' Association, and his appointment to the Government emergency service meets with universal approval.

Mr. Charles H. Ewing has been appointed vice-president of the Philadelphia & Reading, with office at Philadelphia, Pa. Mr. Ewing entered the company's service in 1883 in the engineer corps construction department, and with the exception of several years' service as chief engineer of the Central New England railway, has occupied many important positions in the Philadelphia & Reading for over twenty-five years, and was latterly general superintendent. Mr. F. M. Falck has been appointed General Manager, both appointments taking effect in December.

Hon. John F. Hylan, who has been elected and installed as mayor of New York, is a member of the Brotherhood of Locomotive Engineers, Division 419, Brooklyn, N. Y. Mr. Hylan is from Greene County, N. Y. In 1887, he was engaged laying the tracks of the Brooklyn elevated railroad, and was shortly given a position as fireman and promoted to an engineer. He studied law at night and graduated from the New York Law School in 1897. He was elected county judge of Kings county, and in the recent election for mayor had the largest plurality of any candidate that ever ran for the office. He retains a warm interest in the welfare of railroad men.

Mr. L. T. Hamilton, formerly manager of the advertising and specialty department of the National Tube Company, Pittsburgh, Pa., has accepted a similar position with the Walworth Manufacturing Company, Boston, Mass. As noted in our pages some months ago the Walworth company purchased the Kewanee works from the National Tube Company and Mr. Hamilton's familiarity with the "Kewanee" products eminently qualifies him for his new position. His marked success in training specialty students and in supervising specialty and sales promotion work has won for him an enviable reputation. He is a graduate of the University of Illinois, and became associated with the Western Tube Company in 1897, advancing from claim department and secretary to sales manager. In 1908 he became associated with the National Tube Company, and became identified with the remarkable advertising success of the company's products. He was elected first president of the Pittsburgh Publicity Association. Mr.

L. T. HAMILTON.

W. L. Schaeffer, formerly assistant to Mr. Hamilton in the service of the National Tube Company, succeeds to the position held by Mr. Hamilton as manager of the advertising and specialty department.

Mr. Lewis A. Larsen has been appointed assistant to the president of the Lima Locomotive Works, Inc., with headquarters at Lima, Ohio. Mr. Larsen was born at Ridgeway, Iowa, in 1875. He received his early education in the

LEWIS A. LARSEN.

public schools of Ridgeway and Decorah, Iowa, and Upper Iowa University, Northwestern University and St. Paul College of Law. In 1897 he entered the service of the Chicago Great Western Railway as clerk to the master mechanic. He held successively the positions of chief clerk to the superintendent of motive power and was later chief clerk to the assistant general manager. In 1904 he resigned to accept the position of chief clerk to the superintendent of motive power of the Northern Pacific Railway at St. Paul. In November, 1906, he became associated with the W. H. S. Wright Railway Supplies, representing the Railway Steel Spring Co., Pittsburgh Forge and Iron Company and others, and in 1907 he entered the service of the American Locomotive Company. In 1909 he was appointed assistant to the vice president in charge of manufacturing and in July, 1917, was appointed assistant comptroller, which position he has held up to the present time. Mr. Larson had a wide experience in railway operation, particularly in mechanical department matters and an equally valuable experience in locomotive building. For several years past he has been a special lecturer in the Alexander Hamilton Institute. New York, and has contributed a number of papers to the railroad and technical magazines of the country.

Merging of the Economy Devices Corporation and Franklin Railway Supply Company.

The consolidation of the Economy Devices Corporation and the Franklin Railway Supply Company into one organization, to be known as the Franklin Railway Supply, Company, Inc., has been made with the following as the board of officers: J. S. Coffin, chairman of the board of directors; S. G. Allen, vice-chairman; H. F. Ball, president; Walter H. Coyle, senior vice-president; J. L. Randolph, vice-president in charge of western territory; C. W. Floyd Coffin, vice-president in charge of eastern and southern territory; C. L. Winey, secretary and treasurer; Harry M. Evans, eastern sales manager; C. L. Burkholder, western sales manager; Hal R. Stafford, chief engineer, and William T. Lane, mechanical engineer. All of the officers are men of wide experience in the railway supply department and have been prominently identified in engineering and construction work.

Call for Railway Men.

Announcement has been made by the War Department that volunteers are now being accepted for a provisional reinforcement railway regiment, for the National army, which is being organized at Camp Grant, Rockford, Ill. Men are wanted who have qualifications in railway construction, operation and maintenance; shop work and transportation. Applications are received at all of the principal recruiting stations.

Railroad Equipment Notes

The Pacific Electric is building car shops, 75 by 220 ft., at Torrance, Cal.

The Essex Terminal has ordered 50 gondola cars from the Canadian Car & Foundry Company.

The Republic Creosoting Company, Indianapolis, Ind., is inquiring for five 10,000-gal. tank cars.

The Lehigh Valley has let contract for building a boiler house 40 by 118 ft. at Perth Amboy, N. J.

The Indiana Refining Company, Lawrenceville, Ill., is inquiring for 25 8,000-gal. capacity tank cars.

The United States Government has ordered 65 gun cars from the American Car & Foundry Company.

T. E. Hamman, Milmine, Ill., has ordered five box cars from the Central Locomotive & Car Works.

The Central of Brazil has ordered 2 Consolidation locomotives from the Baldwin Locomotive Works.

The Alabama & Vicksburg has ordered 2 Mikado engines from the Baldwin Locomotive Works.

The Oregon-Washington Railroad & Navigation Company has let the contract for a roundhouse at Tacoma, Wash.

The Santa Fe has commenced construction work on its new machine shop building at Temple, Tex. It is to be 60 by 100 ft.

The Louisville & Nashville has ordered 300 steel underframes for 50-ton gondola cars from the Pressed Steel Car Company.

The Great Northern has ordered 1,138 tons of steel from the American Bridge Company for the renewal of 160 inner pockets at ore dock No. 3, Allouez, Wis.

The Glen Nina Tank Line, N. M. Pierce, owner, Buffalo, N. Y., has orwered 50 8,000-gal. capacity tank cars from the Pennsylvania Tank Car Company.

The Norfolk & Western has ordered from the Union Switch & Signal Company 15 signals, style S, for use on the Big Sandy division, near Kenova, W. Va.

The Union Pacific is to install a mechanical interlocking plant at Republican River Bridge; Saxby & Farmer machine, six levers. The material has been ordered from the General Railway Signal Company.

The U. S. Government has placed orders for 4,975 cars for American forces overseas, as follows: 2,250 box, 1,725 gondolas, 500 flat, 250 tank and 250 refrigerators.

The New York Central is understood to have reserved space with the rail mills subject to government requirements for the rolling of about 150,000 tons of standard section rails.

The French Government has ordered 1,000 steel underframe flat and 850 steel underframe gondola cars of 60 cm. (1 ft. 11⅝ in.) gauge from the American Car & Foundry Company.

The Philadelphia & Reading is reported to have purchased about 3,000 tons of rolled and cast steel for the construction in its shops of 15 locomotives, 10 freight and 5 passenger engines.

The Illinois Central has been getting bids on 1,000 hopper cars; the Lehigh Cement Copany, Allentown, Pa., for 50 hopper cars; the Richmond, Fredericksburg & Potomac, 100 hopper cars.

The Atchison, Topeka & Santa Fe has ordered a 20-lever, Saxby & Farmer interlocked machine, equipped with alternating-current electric locks, for installation at Morris, Kan. The field work will be carried out by the Santa Fe's regular construction forces.

The Gulf, Colorado & Santa Fe company is contemplating the construction of a freight station and a machine shop at Temple, Tex. The proposed machine shop will be 60 ft. by 100 ft., with concrete foundations, brick walls, machinery foundations, electric light, steam heat and tar and gravel roof. The structure will cost $15,000, exclusive of machinery.

The Oregon-Washington Railroad & Navigation Company is building a roundhouse at Tacoma, Wash., which will cost about $10,000. The building will contain three stalls, 97 ft. long. It will be a frame structure with concrete pits and concrete footings supported on piles. The contract for the work was let to the E. J. Rounds Construction Company, Seattle, Wash.

The Southern Railway has awarded to the General Railway Signal Company a contract for the construction and installation of automatic block signals between Charlotte, N. C., and Spartanburg, S. C., 76 miles, double track. With

the completion of this work, the Southern will be equipped with automatic block signals from Washington, D. C., to Atlanta, Ga., 649 miles; and alternating current is used throughout.

According to reports, the orders outstanding for cars and locomotives placed last May on behalf of the Russian Government have not been canceled, but work on them has been held up. The orders outstanding call for about 500 large locomotives and 10,000 four-wheel freight cars. The orders for 1,500 locomotives and 30,000 cars which were in contemplation and which were distributed in October and November were not definitely signed and no work has been done on them.

Press despatches from Athens state that ten monster American locomotives are standing on a side track at the Piraeus, gradually rusting away for lack of use. They are evidence of the progressive modern methods which a recent government railway administration sought to put into practice without, however, making due calculations in advance. The engines were greatly admired when they arrived, but when they were put on the tracks it was discovered that the light rails almost flattened out with their weight, and the bridges along the main routes were not strong enough for them.

The M. C. B. and the M. M. Conventions.

A meeting of the Executive Committees of the Master Car Builders and the American Railway Master Mechanics' Associations was held at the Hotel Biltmore, New York, on Dec. 20, and after disposing of the routine business, the question of holding the annual conventions was discussed at length, and on motion it was agreed that on account of continued war conditions and the necessity of every railroad man being at his post that no conventions be held this year.

Utilizing Exhaust Steam.

In the interest of economy much saving may be made during winter by the careful use of exhaust steam. It may readily be applied as heating feed water for the steam boiler, for many washing purposes, heating buildings and other purposes. A small investment in additional boiler-room equipment, such as an exhaust steam heater would effect a considerable saving even in a moderate sized plant.

Saving Oily Waste.

Many railroads and machine shops still follow the extravagant practice of burning their oily waste, but scarcity of fats and petroleum products has created wider interest in the reclamation of both waste and oil by extraction in centrifugals, filtering and refining the oil for further use, and drying the waste in ovens. The high price of cotton waste, as well as lubricating and cutting oils, makes reclamation profitable.

Breaking Up Cars for War Materials.

In Great Britain the Ministry of Munitions are licensing various firms to purchase cars, especially those of the older types, in order to break them up to recover the aluminium, bronze, brass and steel. These materials are sent in to the official smelters to be made into war material. Aluminum is especially needed for aircraft. The upholstering is utilized as rags, and the old tires, woodwork, leather, etc., can all be utilized for purposes connected with the war.

Electrification of Swiss Railways

The Swiss Federal Railways have made appropriation for the coming year for the electrification of tracks, including roundhouses, stations, and power houses. It has been decided to proceed as early as possible with the work. This question is rendered all the more urgent owing to the present scarcity and high price of coal, and, on the other hand, it is understood that the principal difficulty with reference to the electrification at the present time is the great scarcity of the necessary electrical material and particularly of copper.

New Rolling Stock for Chile.

By a recent proclamation of the President of Chile, an appropriation has been made for the use of the Arica-La Paz Railway to be employed in the purchase of 100 steel freight cars of 25 tons capacity, and 3 Mallet locomotives. Details may be had from the Ministry of Railways, Santiago, Chile.

Wood's Latest Invention.

William H. Wood, engineer, inventor and builder of special machinery for forging, riveting, flanging and other purposes, has perfected a hydraulic shell testing press for testing shells to 18,500 pounds pressure, and to work from an accumulator pressure of 1,500 lbs. to the square inch. Particulars of this and other devices may be had on application to W. H. Wood, Media, Del. Co., Pa.

The greatest favor you can confer on anyone is to give him a chance to do his best.

But it's no trouble to find trouble.

Books, Bulletins, Catalogues, Etc.

Proceedings of the International Railway General Foremen's Assn.

As announced in our columns last June, the annual convention of the International Railway General Foremen's Association was suspended for this year. The work of the association, however, has not slacked down on account of 1917 being a blank year with them, as far as the convention is concerned. The papers which would have been read in 1917 are nevertheless printed in the form of proceedings. The question of what constitutes an engine failure is dealt with very fully. Meeting the Federal Inspection Laws is discussed. The paper is profusely illustrated, and is divided into parts. Maximum service and minimum wear forms the subject of another paper, and the subject is treated from the influence which proper alignment of parts has in producing the desired effect. The interest a locomotive foreman has or may have in car matters came in for discussion after a long and interesting paper had been published.

These papers were printed and sent to the members, and though the discussions of its topics may not have been as spontaneous as if the meeting had been held, but they certainly contain the results of careful and intelligent judgment. Copies of the proceedings may be had from the secretary, William Hall, C. & N. W., Winona, Minn. No convention will be held in 1918.

The Modern Gasoline Automobile

A new and enlarged edition of the Modern Gasoline Automobile, by Victor M. Page, M.E., has just been issued by the Norman W. Henlay Publishing Company, 2 West 45th Street, New York. His work has already been recognized as the standard work on the subject of the design, construction, operation and maintenance of the gasoline automobile. The present edition extends to 1,032 pages, with over 1,000 illustrations, and 13 folding plates. The book is divided into seventeen chapters, and is in many respects the most complete, practical and up-to-date treatise on gasoline automobiles ever published. It is a popular favorite in automobile schools, and has the fine quality of not being too technical for the beginner nor too elementary for the expert. Mr. Page's style is remarkable for its clearness, as well as its completeness. His practical hints for locating engine troubles show how carefully he has mastered the subject, and we are convinced that the book will continue to grow in favor. We might add that those having the early edition published six years ago would do well to secure a copy of the new edition, as the improvements and changes in the modern automobile are of prime importance to all who desire a thorough knowledge of the machine. Price, $3.00.

Du Pont Products.

A new edition of the Du Pont Products Book has just been issued by E. I. du Pont de Nemours & Company, and its associates, Du Pont Fabrikoid Company, Du Pont Chemical Works, the Arlington Works, and Harrison, Inc. It lists all the products of the above concerns and describes their uses as well as who uses them. On account of the enormous expansion of the enterprising firm's business made necessary by the war and by the inability of this country to longer import many of its chemicals and raw materials, it became necessary for the Du Pont Company to greatly expand its industrial activities, and the purpose of the Du Pont Products book is to tell the public of the hundreds of commodities they make and sell, many of which until recently had never been made on this continent. Every mercantile, professional, industrial and particularly railway supply man should have a copy of this book which extends to 192 pages and is elegantly bound. Copies may be had on application to the company's main office, Wilmington, Del.

Tests of Welded Joints.

An interesting series of tests of strength of Oxacetylene welded joints in mild steel plates has been completed by the Engineering Experiment Station of the University of Illinois. Specimens were supplied by the Oxweld Acetylene Company of Chicago, and the result of the tests showed with no subsequent treatment after welding, the joint efficiency for static tension was found to be about 100 per cent for plates one-half inch in thickness or less, and to decrease for thicker plates. The joints were strengthened by working after welding, and were weakened by annealing at 800 degrees C. For static tests and for repeated stress tests, the joint efficiency frequently reached 100 per cent; the efficiency of the material in the joint is less, indicating the advisability of building up the weld to a thickness greater than that of the plate. In general, the test results tend to increase confidence in the static strength and in the strength under repeated stress of carefully made oxacetylene welded joints in mild steel plates. Copies of the Bulletin M. 98, may be obtained from C. R. Richards, Director, Urbana, Ill.

Industrial Motors.

The second of a series of catalogues of industrial motors has just been distributed by the Westinghouse Electric and Manufacturing Company of East Pittsburgh, Pa. This is known as Catalogue 30 and covers the company's complete line of direct current motors and generators for industrial service. After several pages giving general information regarding the ordering, classification and selection of direct current motors there follows complete descriptions, rating and dimensions for type SK commutating-pole motors, various modifications of type SK elevator motors, reversing planer motor equipment, type CD motors, type SK and CD motor generators and arc welding equipment. Much new information is given, especially on such subjects as arc welding, headstock equipment and battery charging service. The new catalogue is identical in size and will fit the binder for the company's line of catalogues covering supply apparatus and small motors.

Elements of Electrical Engineering

This notable work is a text-book for use in colleges and technical schools by William S. Franklin, New York, and published by the MacMillan Company. It is finely printed and elegantly bound and extends to 475 pages, with numerous illustrations. It is the first volume of a projected series extended to review and survey elementary and applied electricity and magnetism, and present direct-current machines and systems. Price, $4.50.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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In the Maritime Alps of France

Our illustration this month gives one an idea of the single-arch steel bridge on the Paris, Lyons and Mediterranean Railway in the vicinity of the strongly fortified town of Briançon, close to the borders of Italy. The town is situated on a hill, about 4,300 ft. above sea level; and is near the source of the Durance, which flows down the deep rocky gorge which forms the subject of our illustration. The fortifications command the road between France and Italy across Mount Genèvre.

The position of Briançon gives it a natural military advantage and the surrounding eminences are crowned by strong fortifications, communicating with the town, and with each other, by subterranean passages. One of the heights upon which the village of St. Veran is built is the highest in France, and Briançon is not many feet short of the highest. The fortifications, although they are well built, are of a former day, and the present war, with its modern high-power ordnance, might easily destroy the defenses. It is, however, to be hoped that France and Italy, now allies, will never resort to war to settle differences which can be more easily and more honorably adjusted around the green table.

The bridge which spans the gorge is a single arch, 127 ft. long by 180 ft. high. That means that from the top of the floor to a line joining the abutments it is 180 ft., though the gorge falls away below a thousand feet or more.

In the town of Briançon, floss and silk manufactures are carried on; small iron ware, leather and the making of lavender

STEEL ARCH BRIDGE AT BRIANÇON ON THE PARIS, LYONS AND MEDITERRANEAN RAILWAY OF FRANCE.

water. Briançon chalk is widely known, and Briançon manna, which is a kind of resin, is also exported from this collection of human dwellings, perched like an eagle's nest on the high mountain crag.

Briançon is believed by some authorities to be the ancient city of Brigantium, a military post under the Romans. After the fall of the Roman Empire, this city maintained itself as an independent republic for many years and only became a part of France in 1713. In the closing wars of the great Napoleon, the town made a noble and spirited defense in 1815. Its population is about 7,524. The photograph which we are enabled to give to our readers was taken for the purpose of calling attention to this old, picturesque, and historic town by the famous Paris, Lyons and Mediterranean Railway of France.

Pneumatic Locking Locomotive Reversing Gear

Outside Independent Locking Arrangement—Gear Easily Adjusted—Powerful In Action—Little Wear

An excellent locomotive reverse gear designed by Mr. C. J. Mellin, consulting engineer of the American Locomotive Company, has been brought out by that concern and applied by them to a number of engines which they have recently turned out. The essential features, or rather one of the principal component parts of the apparatus, consists of an ordinary cylinder with a cup-packed piston and a crosshead with a single guide bar, an operating valve, a locking device and a hand-lever with a latch valve in the cab. What looks like the bottom guide for the crosshead is really a pivoted bar, which may be drawn up at one end and in a sense clamped on the underside of the crosshead, and this really forms a clamp which locks the crosshead and prevents any creeping of the mechanism, due to leakage or from other causes. It is this outside or mechanical system of locking that forms one of the distinctive features of the Mellin gear.

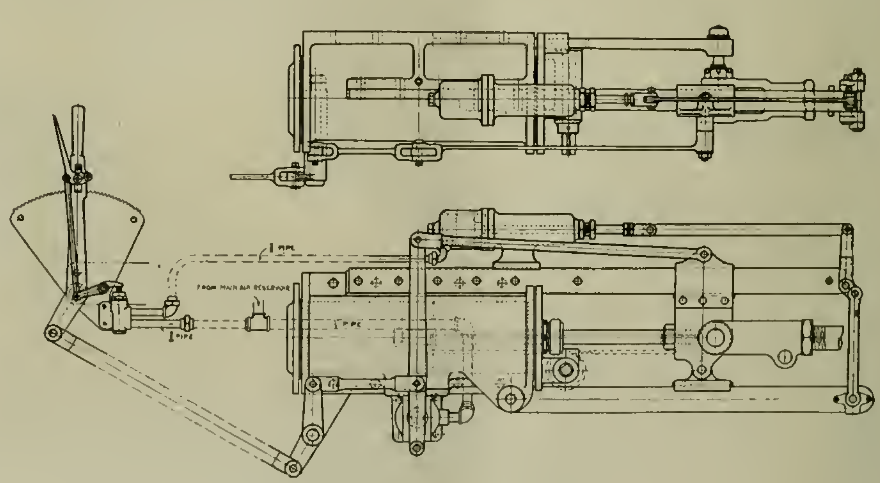
A close inspection of this mechanism shows that the top guide is stationary, and the crosshead entirely encloses it, so that if the lower bar or clamp bar was to fall off it would make no difference to the straight line movement of the crosshead. The action of the clamp bar is simple but effective. On top of the apparatus is placed what is called the locking device. It consists of a cylinder or case containing a spring at one end of which is a piston moving in a small cylinder which is formed as a continuation of the spring case. It may be said of this design that the locking device is of the friction variety, with the spring case combined with a release cylinder. There is a spring, and connected to the pivoted guide, which by the tension of the spring is magnified through a bell crank leverage, and this force grips the crosshead between it and the main guide. The hand lever latch or lock release valve is a simple poppet inlet and discharge valve, subject to the movement of the hand lever latch, by means of a trigger and bolted to the lever fulcrum bracket.

When the reverse mechanism is about to be used, the hand which grasps the lever puts the latch handle up against the main handle and this opens the small poppet valve, referred to above. Air therefore flows into the ⅜-in. pipe leading to the air end of the spring case. The air pressure so introduced moves the small piston and compresses the spring in its case. In consequence of this, the bolt from the spring case moves back and through its connections, loosens the pivoted locking bar under the crosshead.

The hinged lock bar or guide must clear the pivoted shoe on the crosshead by ⅛ in. in its parellel position with the main guide, so that it takes an inclined position when locked; giving more inclination when the crosshead is at the inner end of the stroke, and any slight variation in leverage action which exists on the crosshead by the locking guide in and between these positions, is compensated for by the variations in tension of the locking spring, thus securing an approximately uniform locking pressure on the crosshead for any position of its stroke.

The operating valve, placed in the centre, below the cylinder, is of the rotary type, having lap and passages like an ordinary slide valve but without any stuffing box.

In raising the handlever latch in the usual way, the latch valve automatically admits air into the locking cylinder and releases the lock by compressing the spring and remains so until the latch is again dropped and the lock becomes set. The movement of the handlever transmits motion through the floating lever, shown vertically in central position in our illustration, with the crosshead connection to it as a fulcrum, and this movement opens the operating valve. The motion of the crosshead which follows, transmits motion through the floating lever with the handlever connection as a fulcrum, and closes the valve when the gear is stopped and gripped by the lock at the corresponding position of the handlever. At any movement in either direction of the handlever this action is repeated with all parts except the handlever.



MELLIN PNEUMATIC REVERSE GEAR.

In order to hold the valve gear without danger of undesirable movement, the locking guide is brought in contact with the pivoted shoe on the crosshead, the spring link is adjusted so that its connection to the bellcrank is about ¾-in. outside the vertical center line of its fulcrum and the length of the lifting links are adjusted so as to give a close but free insertion of all connecting pins in the lock.

This is a good example of the growing use of pneumatic reverse lever gears, now that the valve mechanism has become so that with any sort of motion of the engine the valve gear is hard to work. There is no such thing now as "horsing her over," as in former days, and a good, pneumatic reverse mechanism gives a much finer cut off than was possible with the old reverse lever and notched quadrant, however fine the notches were cut.

Physically and Mentally Protected

Sudden Sickness or Faint Provided For—The Dead Man's Handle—Mental Lapses Are Real—How Provided Against—The Stop Signal

It is not often that we stray into the field occupied by the interurban trolley line, but the illustration we are able to give here and what we have to say on the subject represented, is quite applicable to a steam-operated railway. We regard this vehicle and its occupants as properly protected against dangers, physical and mental.

The man in charge is purposely kept alone, without a mate, and he is isolated from the passengers for the purpose of preventing his being distracted and his attention withdrawn from his work by irrelavent conversation. So far this arrangement is good and it shows that, even in a very crude fashion, the idea of protecting the man from the vagaries of his own mind is given some faint attention. At least the tacit acknowledgment of the possibility of his being distracted in certain ways is here made plain.

The man in charge stands at his post, isolated from his fellows, and he governs the movements of the car or of the train by what is commonly called the "Dead Man's Handle" attached to the controller. This handle, as most people know, is made with a knob or button at the top of the point of hand grasp. The button must be pressed down about 3/8 or 1/2 in. against the upward thrust of a small spring; and this pressing down makes connection so that the discs of the controller move with the handle through all its positions. If, however, the pressure of the hand is relaxed or withdrawn, the discs of the controller are disconnected from the handle and in obedience to the action of a powerful spring, they fly back to the zero point, cutting off the flow of electric current to the motors, and at the same time opening an escape valve in the air brake, and thus the brakes are applied in the emergency.

This two-fold action of the dead man's handle deals very effectively with a physical derangement of the normal actions of the man. If he is the victim of heart failure, or is temporarily overcome by an attack of acute indigestion or merely faints in the heavy, drowsy heat of the day, his grasp relaxes, and the train automatically comes to a dead stop. In fact so satisfactory is the action of the dead man's handle that if an automobile is recklessly driven across the front of the train on a road crossing all the man in charge of the power has to do is to let go of the handle, seek safety if need be, and the powerful, but uncomprehending mechanism sets about at once arresting the motion of the train and doing it in minimum time.

Here the danger of sudden and unlooked for physical disability is amply recognized and adequately provided for. All that safety demands for the preservation of the lives of those who have trusted themselves to the company's care has been done fully and properly and with this high-minded single end in view. The isolated man in the cab, though temporarily overcome or permanently stricken down, cannot jeopardize the lives of those whose safety the company has thus far guaranteed.

The isolated occupant of the cab is, however, not yet actually safe from himself. He may be alone, but he is liable to momentary lapses of the mind. He may be

CAR WITH DEAD MAN'S HANDLE STANDING AGAINST STOP SIGNAL.

the prey of sudden impulses or he may be the victim of mind distraction, emotion, fear, flurry or inchoate thought, and so be in a worse plight than the man who failed through physical weakness or the direct attack of disease.

We have all seen the front brakeman of a freight train run ahead of the engine to throw a switch. We have known him to reach a switch which by accident or design had been set right for the oncoming train, and we have seen him deliberately throw the correctly-placed pair of switch-rails to the wrong position almost under the truck wheeds of the engine while he himself was mastered by the relentless power of the idea that he must do something—he must act. Little short of violence will make such a man become rational again, and too often he only awakens from this state of mind when he has succeeded in putting the engine on the ties. This is not an isolated or uncommon case. It exists, and does its deadly work quite as often as the man in the cab fails through physical causes. The brakeman is mentioned as a type. A motorman or an engineman on a locomotive may experience a similar state of mind, yet he may appear to be normal, though the circumstances surrounding him will differ from those of the brakeman.

Instances can be given where a quarrel before the trip may so occupy the attention of the man in the cab, as to inhibit or shut out of his perception the events happening close at hand. The thought or even the hope of a lucrative private transaction may have the same result. Sickness of a child at home, or the distress caused by a slight wound on his hand may be the dominant and all-embracing distraction which to him renders the nearby world only as a shadowy and unrelated realm amid the vital realities around him. Herbert Spencer says in his work on the *Principles of Psychology*, "Among derangements of perceptions, I may refer in passing to those which great fear produces —the misinterpretation of visual impressions being in this state of mind very marked." Again, further on he tells us, "While under a state of depressed spirits, judgment fails because the proportions among the nervous discharges are interfered with in an opposite way." The opposite way referred to, is where the high tide of elation renders discriminations hard to make.

We have before us perceptional misinterpretations which are implied by great fear, and the failure of judgment caused by a state of depression. The commonplace instances which we have just given, such as that of the isolated man left alone with the vision of his sick child, he fearing the worst, or the dread of blood-poisoning from his own slight wound. Neither of these agonies are mitigated by a friendly word to the lone man, and these facts may form for us a picture which most likely must have had its counterpart in the mind of the gifted psychologist as he penned those lines. At any rate they prove that protection of the train and the passengers is not absolutely provided for while the isolated man is not delivered from his own fallible mental make-up.

The car, which we show in our illustration, stands against a stop signal in position. The man in charge, be he the victim of fear or a prey to mental depression or suffering from any form of distraction or preoccupation, cannot pass on into the forbidden block ahead. His forgetfulness produces the same result as

careful watching. It at least makes the necessary halt imperative. The man may be normal or not, but any lapse will be but a failure in one known direction, and the dire results of such failure can be and are anticipated and provided against, for they can be predicted. The stop signal nullifies the results of mental lapses, and the safety of those who trust themselves on board the train is not violated.

This stop signal consists of a bar of iron or steel co-acting with the blade of a semaphore, and when the signal is in the stop position the bar comes down so as to strike and break a bulb of glass, something like an electric lamp, made with a metal end threaded to engage with a socket in the roof of the vehicle. The breakage of this bulb permits air from the trainline to escape and applies the brakes in the emergency. No amount of snow or ice on the bulb can prevent its being thus destroyed.

The fact that mental lapses occur in everyone's experience is attested in the memory of nearly every one of us, for who cannot remember passing by, perhaps only a short distance, the corner of the street he should have turned off at. Our outlook was then perhaps rosy or somber, but it momentarily prevented a clear-cut cognizance and prompt appropriate action. No accident happened, for at that moment we may have carried no responsibiliy to others. The lapse was certainly there, as clearly defined as fainting from overheat. Those who deny the existence of these mental facts or deliberately shut their eyes to proof that mental lapses are realities, are wilful men of the type who go on mistaking casual immunity for a settled condition, or they call it "good luck," until at last the deadly peril that they have compelled others to take, breaks upon all in stern, pitiless disaster. Thus only can some men be made to see the truth. Then, like Macbeth, affrighted by the haunting spectre of Banquo, his dead victim, they behold their own responsibility and complicity, but they are, as he was, powerless to make reparation, and like that guilty monarch at the feast, can only answer with false words the enduring, voiceless, accusation of the dead.

Eight-Coupled Locomotives for the Newburgh & South Shore Railway

The Newburgh & South Shore operates a general switching and transfer service in the industrial section of the Cleveland district. It is a well-built line, with 90-lb. rails and a large percentage of steel ties. There are curves of 25 degs., and the steepest grades are 52 and 60 ft. to the mile, respectively, each grade being two miles long.

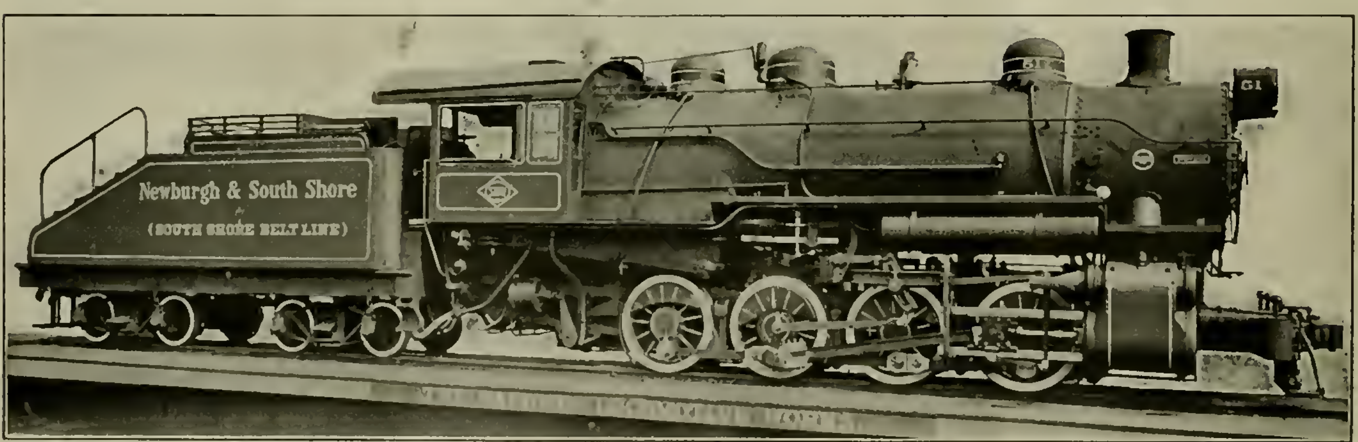
The Baldwin Locomotive Works has supplied six-coupled and Mogul type locomotives to this road, and a heavy eight-coupled engine (here illustrated) has recently been added to the equipment. This locomotive is employed in hauling hot metal ladles. It develops a tractive force of 48,800 lbs., and as the total weight is 221,700 lbs., the ratio of adhesion is 4.54. This is a suitable ratio for a locomotive which, such as this one, operates near industrial plants, where rail conditions are often unfavorable.

This engine is strictly modern in design, as it uses superheated steam and is equipped with a brick arch, power operated fire door, and power reverse mechanism. The boiler is designed to comply with the requirements of the Interstate Commerce Commission and the Ohio State law. It is of the straight top, wide firebox type. The front end of the firebox crown is supported on three rows of Baldwin expansion stays, and there is a complete installation of flexible bolts in the water legs. The throttle valve is of the improved Rushton type, with auxiliary drifting valve. It has a vertical pipe of flattened cross section, so located that the dome can be entered for inspection purposes without dismantling the piping.

The steam distribution is controlled by 12-inch piston valves, which are driven by Walschaerts motion. The driving tires are of vanadium steel, and are all flanged, and flange oilers are applied to the front and rear pairs of wheels. The spring hangers are also of vanadium steel, and frames and spring rigging are designed for severe service. The locomotive is cross equalized in front, and the equalization is divided on each side, between the second and third pairs of drivers.

Special attention has been given the arrangement of the cab fittings, so that the engineman can easily handle the throttle and reverse levers, brake and sander valves, etc., while keeping his head out of the cab window. A radial buffer is applied between the engine and tender. The latter is carried on rolled steel wheels and arch bar trucks. It has a heavy frame composed of 13-inch channels, and the tank is of the water-bottom type, with sloping back.

The Rushton throttle valve used on these engines possesses several features which give a very distinct advantage to the locomotive so equipped. In the first place the whole arrangement is compact and designed to be strong and serviceable. The throttle valve is a double-seated valve of the ordinary type, but in this case the centre is cored out so that



H. R. Thomson, Mast. Mech. EIGHT-WHEEL SWITCHER FOR THE N. & S. S. Baldwin Loco. Wks., Builders.

a 1⅛-inch pin fits loosely in it and it passes through the body of the valve. At the top there is a small single-seated valve which is opened by the upward movement of the central pin, which takes place when the main throttle valve is opened.

When the small subsidiary valve at the top is lifted from its seat a small quantity of steam passes through four passages, each ⅜ ins., to the interior of the large valve, and so on to the cylinders. This has the effect of preventing the throttle, under ordinary running conditions, to close tight, it remains open and feeds a little steam to the cylinders (using superheated steam), while the engine is drifting. This is in connection with the lubricating problem, and the small valve is termed a drifting attachment.

Other minor and incidental advantages may be traced to the presence of the drifting attachment. Owing to the hot steam passing into the centre of the main valve above the collar on the central stem the valve becomes as hot as the case and expands with it so that the valve is easily kept tight on its seat.

When the throttle is opened steam pours to the dry pipe through the four openings mentioned above, and in consequence the first rush of steam to the dry pipe is accomplished without violence.

Further particulars of the engine are given in the table of dimensions:

Gauge, 4 ft. 8½ ins.; cylinders, 24 ins. by 30 ins.; valves, piston 12-in. diameter.

Boiler (straight type)—Diameter, 80 ins.; thickness of sheets, 13/16 in.; working pressure, 180 lbs.; fuel, soft coal; staying, radial.

Fire Box (steel material)—Length, 120 ins.; width, 75¼ ins.; front depth, 75 ins.; back depth, 57¾ ins.; thickness of sheets—sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube, ½ in.

Water Space—Front, 4½ ins.; sides and back, 4 ins.

Tubes—Diameter, 5½ ins. and 2 ins.; material, steel; thickness, 5½ ins. No. 9 W. G., 2 ins. No. 11 W. G.; number, 5½ ins. 36, 2 ins. 242; length, 14 ft. 9 ins.

Heating Surface—Fire box, 197 sq. ft.; tubes, 2,618 sq. ft.; firebrick tubes, 28 sq. ft.; total, 2,843 sq. ft.; superheater, 614 sq. ft.; grate area, 62.7 sq. ft.

Driving Wheels—Outside diameter, 54 ins.; center diameter, 46 ins.; main journals, 10 ins. by 12 ins.; other journals, 9 ins. by 12 ins.

Wheel Base—Driving, 16 ft.; rigid, 16 ft.; total engine, 16 ft.; total engine and tender, 51 ft.

Weight—On driving wheels, 221,700 lbs.; total engine, 221,700 lbs.; total engine and tender, about 355,000 lbs.

Tender—Wheels, number of, 8; diameter of, 33 ins.; journals, 5½ ins. by 10 ins.; tank capacity, 7,000 U. S. gals.; fuel capacity, 12 tons; service, switching.

Tractive Effort and Horse Power

Horse Power Defined—What Is Tractive Effort—How One Goes Up as the Other Goes Down—The Mathematical Conception Involved In Each

In answer to a correspondent who does not think we went far enough in a recent article, we may say that tractive effort, or tractive power, or draw-bar pull, is a mathematical conception which assumes certain things. In dealing with a locomotive engine there are cylinders (stroke and diameter), driving wheels (circumference), and steam pressure (in pounds per square inch). These are the only things taken into account, and the assumptions are the mean effective pressure, resulting from the steam, and the fact that the engine is just starting and has no speed. Now, in the first place, one assumes that 200 lbs. boiler pressure will give, with the throttle wide open, 85 per cent. as the mean effective pressure. This is 170 lbs. An engine having 20 x 24-inch cylinders and a driving wheel diameter of 60 inches will give the following results:

The area of the cylinder is 20 x 20 x .7854, giving 314.16 sq. ins. There are two cylinders and each of them is filled twice, to make one revolution of the driving wheels, whatever its diameter may be. D is the diameter of the driving wheels multiplied so as to give the circumference of the wheel (i. e., by 3.1416).

Now this formula should be remembered by the way it is built up, and not as a mere formula. A person who forgets the formula as such should be able to reconstruct it by knowing how and why it is made. The two cylinders, twice filled for their whole length, make, as it were, a horizontal pillar of steam, with the given area for cross section. The mean effective pressure in this imaginary horizontal pillar, of 20 ins. cross section and 8 ft. long, is the assumed M E P of 85 per cent. of 200 lbs., that is, 170 lbs. All this is equal to one piston of 20 ins. diameter pushed along for 8 ft. at 170 lbs. The whole of this force acts on a driving wheel at the circumference, because the rail is the only point of effective contact of the engine with the outside world.

Now, when we have built up this formula, we may look at it simply as a mathematical expression. Such a view of it shows us that it can be shortened, and that it can be done without reference to the number of driving wheels that may be under the engine. The reason for this is that the circumference of the wheels with which we must deal is a constant, and cannot be varied in the problem, as the steam pressure can be, and the number of wheels present simply provides means to satisfactorily carry weight; that is, a large boiler, of good size and length, requires more wheels under it, in order to keep the axle load within bounds. The number of wheels does not directly affect the tractive effort. It affects it indirectly only, in so far that a large boiler can keep up its pressure under a heavy use of steam more readily than a small boiler can.

The formula derived from all this may be put in the form:—

$$T = \frac{d^2 \times .7454 \times 2S \times MEP \times 2}{D \times 3.1416}$$

Where T is the tractive effort,
d^2 is the cylinder diameter squared.
2S is twice the stroke in inches.
MEP is the mean effective pressure, 85 per cent. steam pressure.
2 is for the two cylinders on an engine.
.7854 is the fraction to get the area from the diameter.

This formula can be made much simpler. In fact all the figures cancel out. We see that .7854 × 2 × 2 comes to 3.1416, which is exactly the figure in the denominator, and when these cancel out we have simply the letters left and the formula wears its old familiar aspect:

$$T = \frac{d^2 \times MEP \times S}{D}$$

Where T is the tractive effort,
d^2 is the diameter of the cylinders, squared.
MEP is the mean effective pressure of 85 per cent. of the boiler pressure.
S is the stroke in inches.
D is the diameter of the driving wheels in inches.

The tractive effort here is 27,200 lbs., and the force developed in the two strokes of the two cylinders, which we have likened to a horizontal pillar, four times the length of one cylinder, is distributed over a distance equal to the circumference of the driving wheels, and this is the distance the engine moves for one revolution. Here it is 15.708 ft. The wheel turns 336.13 times in one mile. This

tractive effort of 27,200 lbs. we said was assumed to be developed when the engine was in the act of starting, and when it had no speed and practically no motion.

Suppose that a weight of 27,200 lbs. to be attached by a steel cable to the drawbar of the tender and carried back over a frictionless pulley, so that the weight hangs down over a cliff behind the engine, and disregarding for the time being the internal friction of the engine and tender, we should find this engine quite able to balance the weight, and we must make one of those curious assumptions a person is often called upon to make in mathematics and say that the engine drew up this weight at no velocity at all. That is practically impossible, but it enables us to think of the engine winning in this tug-of-war, so infinitely slowly that it just theoretically wins and no more.

Now, going on to what we call work, in the mathematical sense of pressure acting through distance, the engine is not doing any, as long as it practically only balances the weight of 27,200 lbs. When the movement becomes apparent and measureable, then it is work. When the time element is introduced—that is, when a definite amount of work is done in a specified time—we have horse power. One H. P. is equal to 33,000 lbs. raised one foot in one minute. We have just been considering an engine with a calculated tractive power of 27,200 lbs. and at every revolution of the driving wheels the engine advances 15.708 ft. The wheels revolve 336.13 times to cover a mile, and they do this whether the engine is running fast or slow, no more, no less. In order to lift the weight 15.708 ft. the engine would have to develop 427,257.6 foot-pounds of work. If done in one minute it would require 12.9441 H. P.

This brings us to the point where it is evident that there is a reason why an increase in H. P. is brought about when the engine is run at higher speeds. At high speeds steam is cut off early in the stroke, and a good deal less steam is used at each stroke, for this reason—the mean effective pressure on the road is far less than used just at the start. This does not at first sight look reasonable, but as a matter of fact it is true. Suppose the engine is traveling at about 40 miles an hour, with reverse lever notched up near the center, and early and short cut-off brings the M. E. P. down to say 75 lbs. We find by calculation that the H. P. under these circumstances has gone up very considerably under the comparatively light steam pressure, and using the tractive effort formula we find the tractive effort has correspondingly gone down. The apparent anomaly disappears when we remember that the fast moving engine receives in its cylinders, a scanty supply of steam, much oftener per minute, and if one may so say, what steam does come in enters in a heavy gush at the beginning of the stroke, is quickly cut off, and eventually brings back-pressure down to a small figure, as the steam easily clears itself through the exhaust.

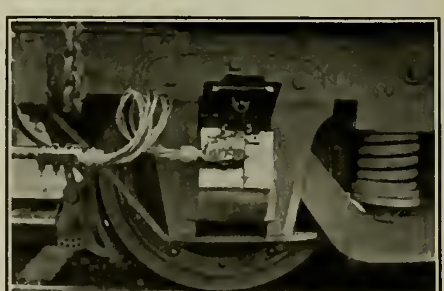
To prove this by figures, say the mean effective pressure has gone down to say 75 lbs. At 40 miles an hour the engine passes over 3,520 ft. in one minute. Each revolution of the driving wheel developed 12.9441 H. P. (say 12.95) and at 40 miles an hour, or 3520 ft., it developed 7,600,158 foot-pounds, or 230.3007 H. P. At this speed with M. E. P. at 75 lbs. the calculated tractive effort is 12,000 lbs. instead of 27,200 as it was at the very start, but the H. P. has gone up from 12.95 to 230.3007 H. P. It is evident from this reasoning that a locomotive could not sustain its maximum tractive effort at anything but a pace so slow that it may be practically disregarded. The tractive effort or starting power or draw-bar pull is really a mathematical abstraction, but it forms a convenient method of comparing one or more engines together. Our calculations here give us a good hint as to why an ample boiler with good steaming qualities is able to do such work amid the arduous conditions imposed in modern railway service, where tractive effort has practically no velocity and H. P. has high speed.

Telephoning to a Moving Train

Train Cannot Get Beyond Hope of Recall—A "Lap Order" Can Be Annulled Before Too Late—Connection to Rails by Wheels to Car—Anyone, Anywhere with Telephone Can Reach a Moving Train

There have been many instances in the past where a railroad train-dispatcher was the one-man power on the road, and some of the most melancholy and disastrous wrecks occurred by the issuance of what is familiarly called a "lap order." This mistaken form of train-dispatching consisted in giving the same right of way to two opposing trains at the same time. For instance, authorizing a train at A, to run to B; and simultaneously permitting the train at B, to start out on the road for A. Instances have been recorded where the train-dispatcher has discovered his mistake before the opposing trains actually collided, and heart-rending scenes have been enacted in the little office, when frantic calls to stations A and B revealed the desperately tragic condition that the trains had both gone, and were beyond the reach of human help. No stage-made tragedy can ever shadow forth the appalling situation of such a dispatcher, as he contemplates the destruction and death which must shortly follow. He stands there, powerless to help, with the full realization that he has raised up a monstrous Frankenstein which he cannot overcome.

Many ingenious appliances have been brought out with the object of preventing a moving train from ever getting beyond communication. Signals controlled by the dispatcher, automatic block signals, stop signals and interlocking signals probably represent the best methods of insuring safety today, but a step forward seems to have been made, whereby the telephone has been called into requisition to carry information without producing any forced halt, like the stop signal. Information, trivial or highly important, can be given by telephone and the necessary connection can be made by the central office of any city telephone system from any point where a telephone is to be found.



CONNECTION FROM RAIL TO WHEEL AND SO TO THE CAR. CANADIAN GOVERNMENT RAILWAYS.

The fact that there are such states as temporary lapses of the memory, which may come to a man or that distractions may break the continuity of a definite line of thought; are conditions which are beginning to reach the serious consciousness of the railway general manager. They are truths old as the hills, but are now well established. To disregard them is to court danger. This fact cannot be successfully disputed.

One of the many inventions, or in this case applications, of existing facilities to this important function of directly communicating with a moving train from the dispatcher's office, or from any other of-

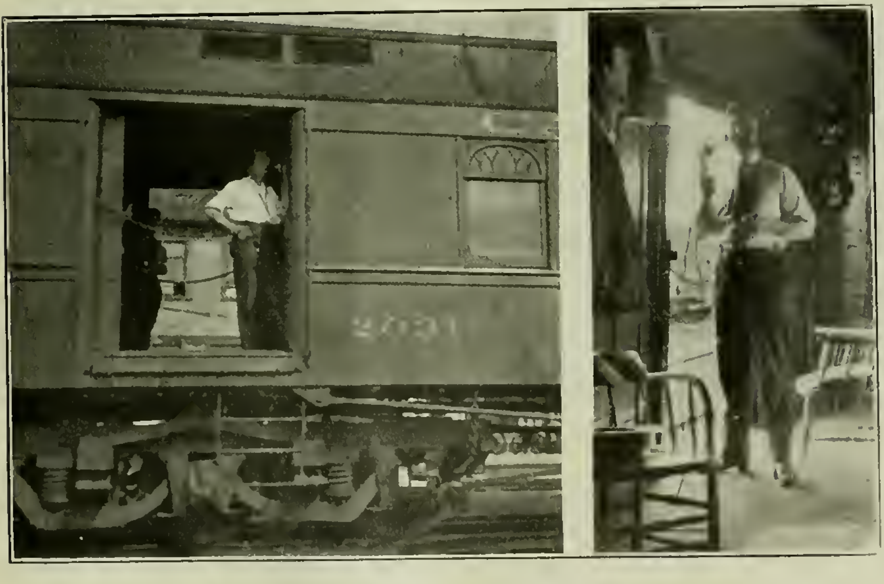
fice on the line, or from a house in the city or town, or from one moving train to another, is the system put in use by the Macfarlane Train Control and Telephone Company. This system also permits telephoning to be done from one end of a train to the other or to any part of the train. The conversation may be held as easily as from house to house. The tone of the voice is just as clear as with the telephone on a city circuit. One cannot tell that the train is moving, as far as the sound in the instrument is concerned. Telephoning under any circumstances is not spectacular but when applied to train movement it is exceedingly useful; in fact, the art rises to the level of a splendid safety appliance.

We are able to reproduce some photographs for the benefit of our readers. The system has been applied to a part of the Intercolonial Railway, by the Canadian Government and appears to give every satisfaction. The main features of the system are quite clearly disclosed in the half-tones. They show the way in which the apparatus is attached, and that the only connection with the rails is through the wheels; they might show, but do not, that there are no wearing parts in connection with the apparatus. It is so simple that it can be installed on any car in three hours and at a relatively low expense. The benefits to be derived from it far outweigh the small first cost.

There is one advantage that goes with a government owned road, and that is that experiments can now and then be tried under suitable authority, by the expenditure of a little public money. Of course this advantage is always liable to abuse, but so far there has been no outcry that the thing has been overcone on the Intercolonial. The telephone may be operated as well as installed independently and three conversations may be held with the train while it is in motion, even when at a speed of sixty miles an hour. The telephone apparatus enables train dispatchers, tower men, etc., to get into instant communication with trains while they are moving.

The train telephone saves a good deal of time and trouble in transmitting messages to freight trains, and in foggy weather enables the engineer and caboose men of a freight train to keep in touch with each other, even if a drawhead pulls out and the caboose is in one block and the engine in another. If connection is made with the regular Bell telephone system, trains can be put in communication with any Bell telephone subscriber. Imagine paying a reasonable fee and speaking to a member of your family about a matter which had suddenly developed, although that member of the family had already been gone half a day. You can get an answer instantly and the decisive "yes" or "no" is yours at once.

CONNECTION FROM OFFICE TO POST AND TO TRACK, CANADIAN GOVERNMENT RAILWAYS.



TELEPHONING A MOVING TRAIN—MAN IN OFFICE COMMUNICATING WITH A MAN ON A FAST MOVING TRAIN. CANADIAN GOVERNMENT RAILWAYS.

However convenient, or whether spectacular or not, telephoning to a moving train by one in authority, concerning its movement or right of way, is always a matter of the greatest importance, and in emergency it may be of superlative concern to those on board. The telephone may not prevent a lapse of memory or a distraction from casting the shadow of doom upon an ill-starred train, but the telephone provides a most efficient method of promptly rectifying a mistake, before it is too late. The train is never beyond the reach of help. It can never be unwillingly abandoned to its fate.

Peat Fuel

Mr. F. B. Haanel, chief of the division of fuels and fuel-saving departments of mines, Ottawa, says that Canada has an enormous reserve of fuel lying undeveloped in her peat bogs, which are situated mainly in Ontario and Quebec. The mention in the past of peat fuel to people of Canada or the United States recalled to their minds the story of the financial failure of company after company which promised great things at the start, but which, in turn, ended in the same way, the money spent and no cheap fuel supplied. Today the story is different. The Federal department of mines has demonstrated that a cheap and satisfactory fuel for all domestic purposes, as well as for many metallurgical operations, can be manufactured from the peat bogs of the country.

The success of the peat fuel industry in this country, or in any country, depends upon the employment of known and tried methods of manufacture by qualified engineers, specially trained in this particular line of work. The manufacture of peat fuel is a successful industry in many European countries, where they employ but one method, namely, the "wet process." The wet process is the one recommended by the department of mines, and is the only one in successful operation today.

Peat fuel, as it occurs in nature, says Mr. Haanel, contains 80 to 90 per cent. of water. This water content must be reduced to between 25 and 35 per cent. before the peat can be placed on the market as a commercial fuel. The use of pressure or artificial heat, or both together, has always proved a failure for reasons both physical and financial. The wet process employs the sun and wind to dry the wet peat as received from the bog; both these agents are ever ready and cost not a cent for their use.

There is every indication that the matter will be taken up with a degree of efficiency, and with sufficient means to guarantee the successful utilization of the peat deposits and that its large use will be speedily established.

Efficiency on the Atchison, Topeka and Santa Fe

New Equipment—Advantages of Using Oil Fuel—Details of the Construction and Repair of Oil Burning Appliances

In the present congestion of railroad traffic incident to the extraordinary demands made upon the management, it is gratifying to observe that there are quite a number of the leading railroads meeting the situation with a degree of efficiency that is altogether admirable. Among these the Santa Fé is particularly prominent, and it must not be imagined that because this great road is largely beyond the Mississippi that it has not felt the pressure of traffic due to war conditions as much as the Eastern roads have felt it. There is little shipping on the Pacific Coast for the Atlantic ports, resulting, of course, in greatly increased tonnage by rail. In Arizona and New Mexico the copper and zinc industries have had abnormal stimulation, and the demand for foodstuffs has produced large prices for a heavy grain crop. The oil industry has felt the interruption of supplies from Old World sources, and the enormous increase in the use of gasoline continues to stimulate that industry to an abnormal extent. The largest passenger traffic in the railroad's history has also been carried to the Pacific from points east of the Rio Grande. The growing popularity of Southern California as a resort and playground in both summer and winter is enormous, and at no time has there been any shortage of equipment with the exception of box cars. Such times, however, were of brief duration, and there would have been no shortage at any time if the connecting lines had been able to return the cars promptly, or had there been ships enough to receive that which the company was prepared to deliver.

The reports show that the company has made heavy expenditures for rolling stock, motive power and other forms of equipment. Orders were placed last year for 130 of the heaviest type of locomotives, 70 of which were of the 2-8-2 type, 10 of the 4-8-2 type, 20 of the 4-6-2 type, and thirty of the duplex Mallet, or 2-10-2 type. The average weight of these locomotives is about 325,000 lbs. All are equipped with superheaters, brick arches and outside forms of valve gear, mostly of the Walschaerts type. In regard to freight cars, 2,430 have been ordered during the year, and this equipment is being rapidly delivered and placed in service.

Much of the fine degree of preparedness and continued spirit of enterprise has been owing to the masterly management of Mr. E. P. Ripley, the worthy president of the Santa Fé system. While his work has been largely in the operating department, his studious and trained mind has mastered all of the engineering problems of railroad work. Polished by Eastern education and broadened by the vastness of Western enterprise, he is an excellent railroad president. All along the great railroad system the improvements in construction work are particularly marked. New concrete roundhouses have sprung up all along the line, with engine pits and flooring smooth as pavement. Almost every known kind of mechanical equipment is in polished profusion, and a spirit of intelligent activity and fraternal feeling is manifested in all ranks, even to the humble but trustworthy track walker. They who have eyes to see may behold him in the dead and silent night with his vigilant eye directed toward the landslide, the washout, the broken rail, with wartime additional terrors of concealed attack—the explosion, the stab in the dark, the unimaginable but suspected stroke of frightfulness. His aim is to guarantee a clear and unbroken track for the railway traffic on schedule; when the engine attendants at the division points, mud-beplastered and smoke-begrimed, working underneath tanks from which embryo icebergs as big as blacksmiths' anvils are suspended, or working like iron puddlers underneath red-hot fireboxes, with a gale far below zero sweeping over their chilled bodies, they toil uncomplaining and alone.

Of such material men are made; men who rise to the occasion when the call comes. Three thousand of them are now in battle harness, among them three are now lieutenant-colonels, 94 commissioned officers, and volunteering or drafted are

THE CALIFORNIA LIMITED ON THE ATCHISON, TOPEKA AND SANTA FE RAILWAY.

2,903. Those who return after setting the Huns right will find the Santa Fé glad to receive them.

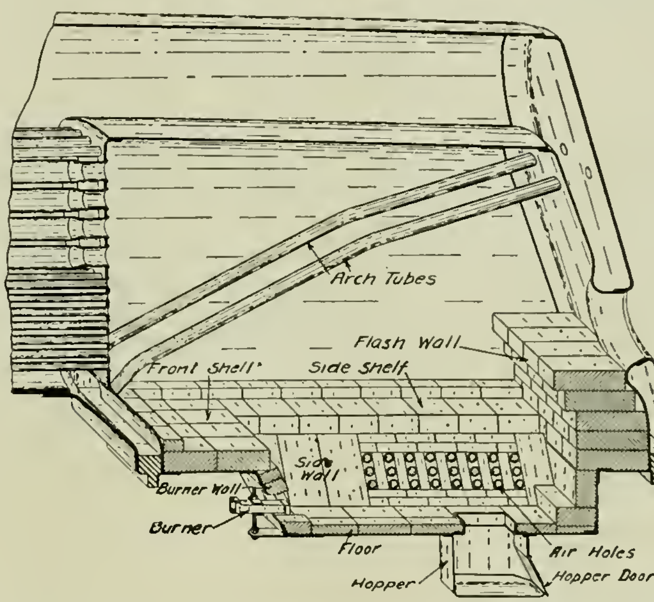
This leads us to observe that a decided advantage has accrued to the Santa Fe and other Western roads by the use of oil fuel, and the apparently inexhaustible supply of the oil has engaged the attention of the leading railway men, and, as may be expected, a variety of devices, or rather a number of variations of the same general method of providing appliances for the burning of the oil, have come into use, and a brief description of these with the addition of some of the latest changes and improvements that are being made, cannot fail to be of interest at this time.

In the matter of the repairing of these appliances it may be briefly stated at the outset that the repairing that may properly be classified under the heading of running repairs consists chiefly in maintaining the brick arch work which is an essential feature of the appliances in oil burning locomotives. The best kind of fire-brick in use rapidly deteriorates in the great heat to which it is submitted, the wasting of the brick being more rapid than in the fire-brick arches that are in use in coal burning locomotives, and the danger to the lower parts of the fire-box from exposure, in the event of portions of the brick work falling away, is consequently great—the average period of service of parts of the brick work not exceeding three weeks in the case of locomotives that are in constant service.

Fortunately the fire-boxes of coal burning locomotives lend themselves readily to oil fuel consumption. On some railways the changes necessary have been made with a degree of rapidity that seems surprising, and in districts where oil fuel is plentiful and consequently cheap, and where coal is high priced on account of having to be conveyed considerable distances, the saving in almost every instance has been considerable. In this regard it may be stated that a general comparison between the prices of oil fuel may be obtained by estimating the price of oil at two-and-one-tenths of a cent per gallon, and taking the comparison between oil and coal on the generally accepted basis that 200 gallons of oil is equal in calorific quality to one ton of coal. It will thus be seen that coal costing $4.20 a ton would be equal to the price of that amount of oil required to produce the same quantity of heat. The work necessary in handling the material is much less in the case of oil, and if the price of coal is higher than the figure quoted, it can be seen that there is an economical advantage to be gained by the use of oil as fuel. In regard to the steaming qualities of the locomotives all authorities agree that the oil fuel, properly managed, produces better results than the best coal. This is not to be wondered at, as the almost complete absence of matter that may be said to be non-combustible, and which is always present in greater or lesser quantities in coal is almost entirely absent in even the lower grades of crude oil.

In making the necessary changes from a coal burning to an oil burning locomotive the grates and side bearings on which the grates rest are removed and a cast-iron plate is put in 5 or 6 ins. below the mud ring and extends over the entire space covered by the fire-box. There is generally three openings in this plate measuring 9 x 15 ins., one opening being near the front end of the fire-box the next in the centre and the third opening near the back of the fire-box under the fire-box door. The ash pan and dampers may be left as they were. The cast-iron plate is entirely covered by fire-bricks in order to protect it from the intense heat of the burning oil. On this brick foundation a wall of fire-brick is built reaching as high as the level of the bottom flues in front, and nearly as high as that of the fire-box door along the sides and back fire-box sheet. The thickness of the fire-bricks is usually 5 ins. The three openings are not covered by fire-bricks, their purpose being to admit the amount of air necessary for combustion. It may be added that the cast-iron plate forming the bottom of the fire-box has sides attached to it securely filling the space between the bottom of the firebox and the mud ring.

A brick arch resting securely upon the side walls of brick, and extending across the fire box from side to side and beginning at the front end of the fire-box and reaching backwards about 4 ft., the part of the arch nearest the firebox door being about 18 ins. higher than the front part near the flues. This brick arch is perhaps the most variable appliance used in the apparatus, sometimes taking the form of two or three separate arches—a short arch in front measuring 3 ft. in length, another arch under the fire-box door one-and-a-half feet in length, and an overhanging arch centrally located, 2 ft. in length, and occupying a central position a few inches higher than the other two arches. The dimensions and location of these separate arches have been a matter of much experiment among railway men, the aim being to obtain the most perfect combustion by causing the oil fuel to deflect against several masses of heated fire-brick thereby insuring the combination of the inflammable oil before passing to the flues.

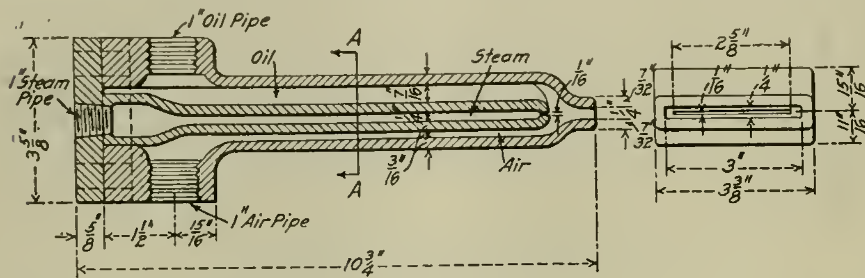


DETAILS OF FRONT END BURNER FURNACE, ATCHISON, TOPEKA & SANTA FE.

The oil tanks are located in the pit of the water tank and the oil, before being injected into the firebox is heated usually by a coiled pipe passing through the oil tank. This pipe may have its connection with the dome or steam chamber on the boiler head, and in some cases the steam passing through the pipe is conveyed back to the boiler through adjustable valves and nozzles as in the case of the action of the injector. In others an escape valve is opened sufficiently to allow a small jet of steam to pass into the air. The proper degree of temperature to which the oil should be heated to produce the best results has been carefully determined and the variations are incident to the degree of thickness of the oil, the thickest kinds of oil should be heated to a temperature of between 150 and 170 degs. F. The thinner oils from 100 to 120 degs. F. The temperature should be carefully observed and a measuring rod may be readily suspended in the forward tank nearest to the fire-box. The general method of heating the oil is to open wide the steam valve and heat the oil readily and when the proper degree of heat has been reached the valve may be shut, and

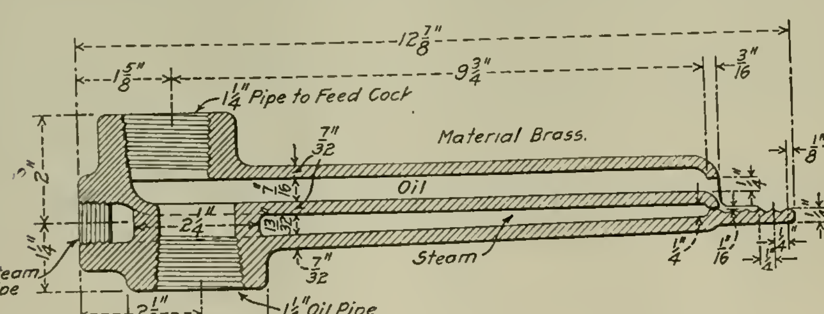
another application made when necessary. Climatic conditions readily suggest the applications necessary. The openings on the top of the oil tanks should be allowed to remain open except when the tanks are entirely full when there may be a danger of splashing. It is hardly necessary to add that lighted torches should be kept away from these openings.

The apparatus for injecting the heated oil into the fire-box is located under the mud ring on a line with the centre of the fire-box. The atomizer is a simple in-



SHEEDY OIL BURNER.

jector having a pipe connecting with the oil tank, the pipe being attached a short distance above the bottom of the tank in order to avoid conveying water with the oil, the oil generally being lighter than water, the water finds its way to the bottom of the tank where there are means applied to drain it off. In addition to the oil pipe there is also an air pipe, the oil pipe and air pipe being 1¼ ins. in diameter. A steam pipe ½ in. in diameter connected to the boiler, leads into a hollow cylinder surrounded by another cylinder, the apparatus being of sufficient



VON BODEN-INGLES OIL BURNER.

length to extend from the outer wall of the boiler to which it may be conveniently attached inward beyond the mud ring and brick work into the fire-box. The inner cylinder has a small opening and the outer cylinder has a larger opening parallel to each other, and so adjusted at an angle carefully calculated so that when the valves with which the pipes are fitted are opened the jet of steam will project the spray of oil against the inner centre of the slanting arch to which we have already alluded.

In starting the fire in locomotives equipped with oil burners it is necessary that steam or compressed air pressure should be applied. These can usually be supplied at the starting points on railroads, and when greasy waste or other inflammable material is placed in the fire-box and lighted the valves should be slowly opened and the oil will readily ignite. As there is almost always some water in crude oil there is a danger of the fire going out and the oil may, if permitted, continue to run into the fire-box before the brick work has been sufficiently heated to ignite the oil, the fact should be carefully noted, as a considerable flow of oil into the pan might cause a serious explosion while relighting. The quenching of the fire by the mixture of water may readily be detected by the appearance of white smoke coming out of the smoke stack. The odor arising from the oil on the partially heated brick work is also a ready means of detection.

The firing up of oil-burning locomotives where there is no available pressure must be done in the usual way with sufficient wood to raise a pressure of steam, in which case care should be taken not to damage the brick work by throwing wood carelessly into the fire-box. The front end appliances are the same as in coal burning locomotives, with the exception that there is no need of netting or other spark-arresting devices. The omission of the netting calls for extra care at the time when a fire of wood has sufficiently heated the water so that a pressure of steam may be applied to the oil-burning device. A shower of sparks may then be expected and it is well to observe that there is no valuable material in the vicinity. Generally speaking the oil-burning locomotives are entirely free from the evil of starting fires in their vicinity.

A peculiarity in the burning of oil fuel is the tendency of the flues to collect a gummy substance on the ends that project into the fire-box, and even with the most careful management of the fuel and no appearance of smoke soot will accumulate in the flues. In coal burning engines the cinders and particles of coal which are drawn with considerable force through the flues tend to prevent the accumulation of soot. In oil-burning engines there is no such cleansing quality in the fuel but the defect is easily remedied by an occasional application of sand. This is usually admitted into the fire-box through an elbow-shaped funnel inserted through an opening in the fire-box door. when a quantity of sand is admitted in this way, it is well that the engine should be running with a long stroke of the valves, and the throttle should be opened wide. The strong exhaust will draw the sand through the flues with such velocity that the gum and soot will be cleaned with a few blasts. Much of the success that has attended the introduction of oil fuel in locomotives has been the intelligent harmony that has existed between the engineers and firemen in working together. The handle of the oil-supply valve is as important a factor in the management of the fire as the throttle or reverse lever is in the control of the engine, and when both are worked skilfully together the result leaves little to be desired.

As was stated at the outset the devices are numerous and their applications are various. In some locomotives the oil-injecting apparatus, or atomizer as it is called, is placed in the front end of the fire-box and the spray is injected backward under a system of fire-brick work suited to that direction. It is claimed that the oil fuel thus being driven in a direction away from the flues the opportunities for complete combustion of the fuel before the unburned particles of the spray can reach the flues is greater than when the oil is projected towards the flues. The advantages, however, appear to be more imaginary than real, as the change of position of the appliances has not changed the consumption of oil to any marked degree.

Casehardening.

A quick method for case hardening consists in heating the material to be hardened to a red heat and submerging it in a bath of molten cyanide of potassium, leaving it from one to five hours, according to the size of the article to be hardened. Cyanide of potassium gives off poisonous fumes, consequently the vessel containing it should be placed in a furnace with a draught.

Oxy-Acetylene and Electric Welding

At a recent meeting of the Canadian Railway Club, held at the Windsor Hotel, Montreal, Mr. A. F. Dyer, general foreman, welding department, Grand Trunk Railway, Montreal, read a paper on the subject of "Oxy-Acetylene and Electric Welding and Cutting Processes in Locomotive Works," in the course of which Mr. Dyer stated that the processes have proved themselves fitly to be ranked among the greatest time and labor savers, and also money savers, introduced for a long period. For instance, in the not very distant past, a locomotive with a broken frame was due for a period of several days in the shops before they could strip down one side and remove the frame to the smith's shop, weld it and perhaps have it machined and then replaced. Now we drop the pair of wheels which may cover the break, cut out the crack with the cutting torch to the shape of a double V at an angle of 90 degress, clean off the oxide caused by cutting and weld up with the metal electrode, using soft steel or Swedish iron. A frame 4 in. or 5 in. being cut and welded in under 14 hours, and it can be done in less time by having two operators on the frame at once, but the men do not like facing each other's arcs, as when they are changing the filling rods their eyes get sore.

Frames, when worn by brake gear and stays, are built up and worn holes are plugged and welded instead of reaming them out to a larger size and thereby weakening the frame. In rebuilding and superheating engines, the same boilers are seldom used on their original frames, and in very few cases do the various holes in angle irons, furnace bearers, etc., come into alignment with frames or boilers, these holes are welded up and redrilled.

The present price of tool steel demands that none shall be wasted, therefore we use it down to the last inch by welding it to tire steel. Twist drills, taps and reamers when broken near the socket end are welded and put into use again. For this purpose we use either the electrode or gas, but in both cases we use vanadium steel filling rods, as we find this gives the best results. Spokes of driving wheels are welded and flat spots on tires have been successfully welded up when it was necessary to do so.

Up to now we have not had much success on cast iron with the iron electrode although with the carbon you can make a fair job, but the gas is unquestionably the best for any of this material. We have successfully welded with the gas, steam shovel engine frames, slides and cylinders by welding in patches of cast iron where worn or broken. When our contract for shells was completed and the lathes that were used for this purpose were being overhauled, it was found that most of the V slide beds were worn down by the tool carriers. These were built up with the gas, which saved machining these beds down in man cases ⅜ in.

In regard to boiler work, most of the welding is done with the iron electrode using a mild steel or Swedish iron as a filler, it is found that the electric process localizes the heat more so than the gas, though it is the writer's humble opinion that the gas makes a closer and neater weld, as all welds made by the electrode are more or less porous unless hammered up. It pays better whenever possible to do so to put quarter or half sides in order to get out of the fire line in preference to putting in a patch, for, as a rule, however well the patch is welded it generally gives out in from twelve to eighteen months' service, and the same applies to cracks, whereas the half or quarter side should last as long as the firebox.

When a nest of small cracks is found round the staybolts, the bolts are removed and the holes countersunk and welded up. This method has been found to be very successful.

For cutting steel and wrought iron the oxy-acetylene process has practically no competitior, it being impossible with the carbon point to cut as fast or as fine and neatly as the gas torch, although for scrapping fireboxes and frames, the carbon point is cheaper if time is no object and labor cheap.

No roundhouse should be without an oxy-acetylene outfit, both for repair work and as a part of the wrecking outfit. Many days are lost by engines being tied up through parts having to be sent to the nearest big shops for repair, which could be repaired on the spot with a welding and cutting outfit. All large roundhouses should have both processes, as they would pay for themselves over and over again.

There are many different opinions as to which is the best process, no shop is complete unless it has both equipments, although the gas has really the widest range but, on the other hand, a heavy piece of steel or iron needs no pre-heating with the electrode but welding can be commenced as soon as your arc is drawn, 95 per cent of the failures which occur instead of being laid on the process should be placed on the shoulders of the operators.

Welding should not be treated as a side line of the machinists' or boilermakers' business, but should be treated as a trade in itself, as it really is, for it needs the entire concentration of a man's mind, careful study, plenty of practice and a conscientious man to make a welder.

Wherever possible a separate building or suitable space should be provided for bench work, and should be equipped with a suitable furnace for heating and annealing castings, and also plenty of floor room to allow of charcoal fires being built for preheating cast iron jobs for welding.

An unusually interesting discussion followed the reading of Mr. Dyer's paper, in the course of which Mr. Barry of the Oxy-Acetylene Company, said that the company's work came from all over the country, from the smaller roads, such as lumber roads, and contractors' outfits, and the like. They ran up against anything and everything and it is interesting to see what they have accomplished when it comes to acetylene and electric welding. Now, if you wish you can weld fireboxes complete with either the acetylene or electric welding. It is quite immaterial which process you use, and of course, the acetylene operator will claim that his process is the best, but he does not know anything about electric welding. Both processes have their advantages, and you can use both. In using the oxy-acetylene process on fireboxes we have tried the butt weld, and the result looks fine, but on account of the chance of the operator being careless the lap weld is best. I beg to differ from Mr. Dyer, as by putting a lap weld in fireboxes, especially in the corners, you can reinforce as heavily as you like, and we have found more success with the lap weld than with the butt weld, but there is no doubt that in welding side sheets to crown sheets or in the corners of fireboxes, either the butt or lap weld can be used. It depends upon the operator. The same thing applies to steel tank work. Many years ago we started in the manufacture of steel tanks, and my experience was that the lap weld was best. You can reinforce it, and make two welds as against one in the butt weld. Electric welding is also applicable to tank work.

Mr. Royer said that he had seen men calling themselves welders, keeping the flame of their blowpipe at one spot, and fusing the welding rod in the crack to be welded.

It stands to reason that at that one spot the metal was liable to be too hot while the surrounding parts were too cold for proper welding. A good welder should keep his blowpipe moving all the time, so as to distribute the heat evenly at the point he is welding and bringing in fusion at the same time the two edges of the chamfer and the added welding rod.

There is no doubt that a considerable amount of boiler work can be done very satisfactorily, if the men are properly trained, however discrimination should be exercised in boiler work, in using only reliable welders in jobs where failure would be dangerous, and apprentices can be used on parts where failure will not produce accidents.

Other speakers also strongly favored the use of both oxy-acetylene and electric equipment.

Home Shops on the B. & O. Turn Out Refrigerator Cars

New Features in the Design—Insulation Layers Without Air Spaces Between—Collapsible Ice Tanks 70,000 lbs. Capacity, Hold 15,000 lbs. of Ice

The general design shows three layers of ½-in. hair felt in the sides and ends and four layers in the ceiling. This was the original method of insulation used in the first lot of this class of car. This was later increased to four layers in the sides and six in the ceiling, as shown in the cross-section. The cars are all equipped with collapsible ice tanks of the Bohn type, which have been arranged with wire netting applied so as to give 2 ins. air space between the sides and the ends of the car and netting, except at the top of the sides where it has been cut short to permit free movement of the bulkhead to the upper position.

The bulkhead is insulated with 1 in. cork board, secured between a layer of ½ in. and a layer of 13/16 in. lining. Openings are left at the top and bottom to induce circulation. The cold air is led out under the floor racks which are hinged to the floor. These cars are of 70,000 lbs. capacity and are equipped with steel underframes and 5 x 9 ins. second-hand trucks. The latter were previously removed from dismantled steel hopper cars. The capacity of the ice tanks is 15,000 lbs. of ordinary chunk ice. These cars were built entirely at the shops of the Baltimore & Ohio Railroad, with the exception of the steel underframes; these were supplied by the Ralston Steel Car Company.

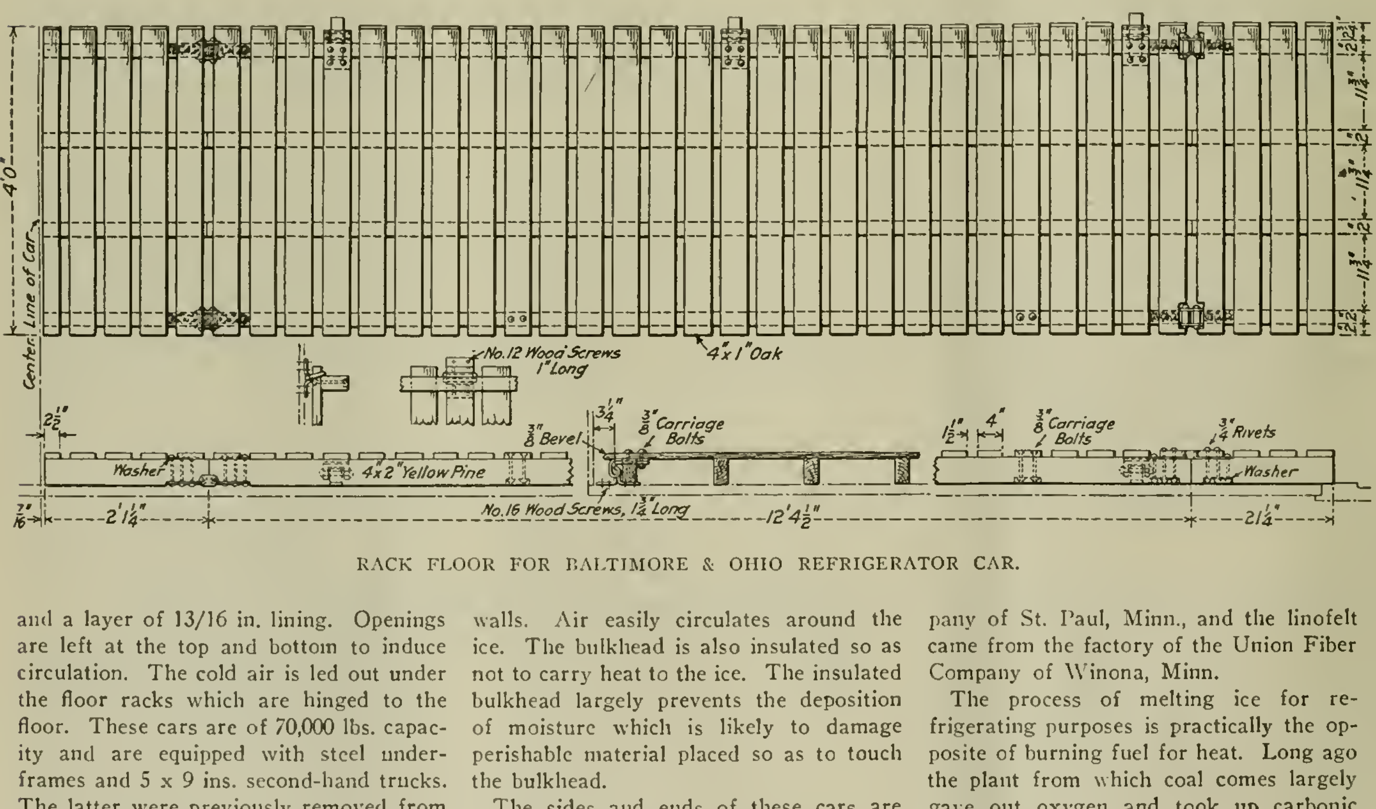
The object of the modification of the usual method of insulation where definite air spaces are provided, is the realization that the effective dead air spaces reside in the insulation itself. Boiler covering made of asbestos and plastered on a boiler does not have any special insulating value because it will not scorch or burn. That is an advantage, but the real heat resisting value is not on account of its inflammability, but because it contains countless minute air spaces formed in the asbestos paste and heat finds these small gaps most difficult to pass over or through. The application here made to these B. & O. refrigerator cars is based on this very principle.

A good circulation of cold air is maintained. The bulkhead of the ice chamber is solid with good sized openings at the top and bottom, and wooden racks are interposed between the floor and the perishable contents. To get the greatest good from the ice, a wire netting holds the ice away from the ends and sides of the car. so that very little heat is abstracted by the walls. Air easily circulates around the ice. The bulkhead is also insulated so as not to carry heat to the ice. The insulated bulkhead largely prevents the deposition of moisture which is likely to damage perishable material placed so as to touch the bulkhead.

The sides and ends of these cars are made of several layers, as follows: Inside lining 13/16 ins. Oregon fir. Two layers approved make of fibrous insulating paper, saturated with an asphaltum bitumen. Three layers of ½ in. flaxlinum or linofelt as approved, and of substantial material, free from low volatile compounds and other undesirable matter. This material is strong, tough, slightly flexible and not easily breakable. Three layers of ½ in. cork board, free from low volatile compounds and other undesirabile matter. It is strong, tough and slightly flexible.

The center and side sills are made of open hearth steel plates and shapes. Draft sills, spaced 12⅞ ins. apart; bottom flanges at the rear of draft sill are connected to the center sill flanges by rivets passing through the flanges and tied together at the bottom by pressed steel follower guides. Center sills tied at the body bolster with cast steel center plate support and filler casting, the surfaces of which are smooth, true and at right angles, and are solidly fitted against all adjoining members. If the surfaces of castings are rough they are ground off or otherwise finished. The bottom of the casting must be perfectly fair with bottom of the center sill reinforcing angles produce a perfectly flat surface for supporting the body center plates. The flaxlinum used was supplied by the Northern Insulating Company of St. Paul, Minn., and the linofelt came from the factory of the Union Fiber Company of Winona, Minn.

The process of melting ice for refrigerating purposes is practically the opposite of burning fuel for heat. Long ago the plant from which coal comes largely gave out oxygen and took up carbonic acid. Burning coal today re-unites the formerly discarded oxygen with the carbon. In the other case the formation of ice necessitates the giving up of heat in large quantity and in order to melt the ice heat is again taken up by the ice and this it draws from all substances around. Salt is often added to melt the ice more quickly, just as good draught and very inflammable fuel makes the fire burn harder. The theory of insulation is to make the passage of heat more difficult from those things we do not want to cool, and this makes the melting ice draw the necessary heat from the perishable contents of the



RACK FLOOR FOR BALTIMORE & OHIO REFRIGERATOR CAR.

car, and those are the things we want to make and keep cold.

The side doors are carefully looked after. Special care has been taken to properly fit the doors to the bevel of the lintel and threshold, chalking the threshold plate as a guide in fitting. The doors are made true and parallel to the door posts. Stiles and rails are of Oregon fir. Sheathing, lining and insulation of doors are the same as side walls of car. The doors are hung by malleable iron hinges, secured with ⅜-inch, of galvanized iron carriage bolts, heads inside and grip nuts outside. No nails are driven into the cap. After the insulation and canvas have been applied the canvas is treated with a coating of hot paraffine, which fills the pores of the canvas and prevents moisture from attacking it and the insulation underneath. A coat of boiled linseed oil is then applied to the edges of the doors, which are left to dry thoroughly before applying canvas. All tacks and nails used are galvanized. Recessed holes for the nuts on door rods are plugged.

Length inside, 39 ft. 8⅝ ins.; length between ice boxes, 33 ft. ⅞ in.; length over sub end sills, 40 ft. 9¼ ins.; length of outside over body, 40 ft. 10⅞ ins.; width over siding, 9 ft. 3¼ ins.; width over frame, 8 ft. 7⅜ ins.; width inside, 8 ft. 3 ins.; width at eaves, 9 ft. 5½ ins.; width over side facia, 9 ft. 7 ins.; width over ice hatch doors, 8 ft. 9⅝ ins.; maximum width over side ladders, 9 ft. 9½ ins.; height inside, floor to ceiling, 7 ft. 6 ins.; height from rail to eaves, 12 ft. 2 13/16 ins.; height from rail to top inside edge of hatch door, 12 ft. 8⅛ ins.; height from rail to top of running board, 12 ft. 11 9/16 ins.; height from rail to top of brake shaft, 13 ft. 10 5/16 ins.; height from rail to center of coupler, 2 ft. 10½ ins.; distance from center to center of trucks, 31 ft. 8¼ ins.; wheel base of truck, 5 ft. 4 ins.; center to center of journals, 6 ft. 4 ins.; size of journals, 5 ins. by 9 ins.; height from rail to top of floor, 4 ft. 13/16 in.; width of side door opening, 4 ft.; length over end sill channels, 41 ft. 11½ ins.; length over striking casting, 42 ft. 8¼ ins.

This car is a good example of a scientifically designed vehicle, intended for a special purpose, and fulfilling that purpose admirably. The railway company built it themselves in their own shop, under the supervision of Mr. F. H. Clark, the general superintendent of motive power of the B. & O. road.

Railway Speed Recorder.

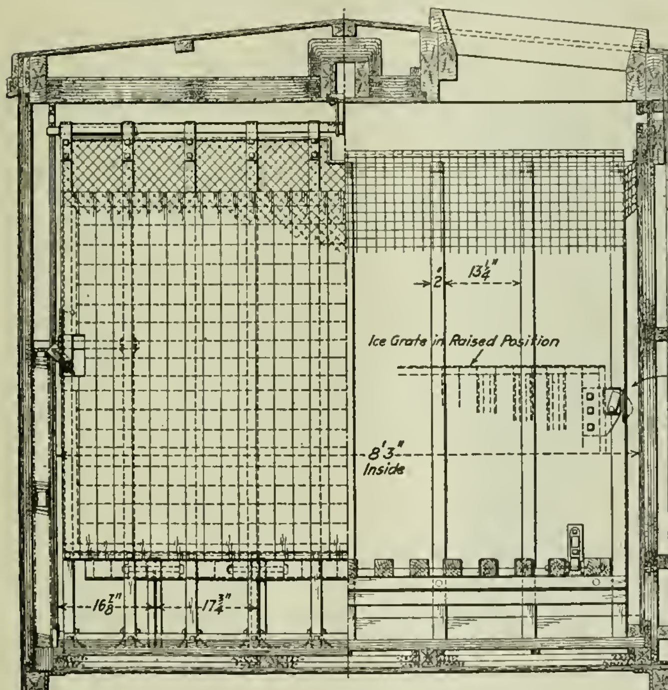
An instrument that will record the speed of a train with some close approach to accuracy, showing the speed variation on every mile of the run, will correct curves of the rise and fall at all starts and stops, should yield data of great value to the engineers as well as to the drivers and traffic managers. All this is claimed for the "Boyer" recorder, made by the Chicago Pneumatic Tool Company, Fisher Building, Chicago, and 9, Bridge-street, Westminster, S.W. 1. The recording paper has vertical lines, ½ in. apart for each mile, and horizontal lines ¼ in. apart for 5 miles per minute. The print of this record is quite easy to follow, though reduced to one-third of the original size. The instrument is driven by a belt engaging a V-rimmed pulley fixed on an axle of the engine truck or a car. The required diameter of this pulley can be calculated to within 1 per cent., and the correction made on the rim after a trial run on the road. The drive is conveyed to a tooth-wheel pump, which forces oil against a piston, the rise and fall of the piston according to the speed of the train actuating the pencil. An indicator, of dial-face type, which may be placed in front of the engine driver, is also actuated, and a clock with pencil mechanism may be added which will trace a time curve on the chart paper.

Locomotive Headlight Law.

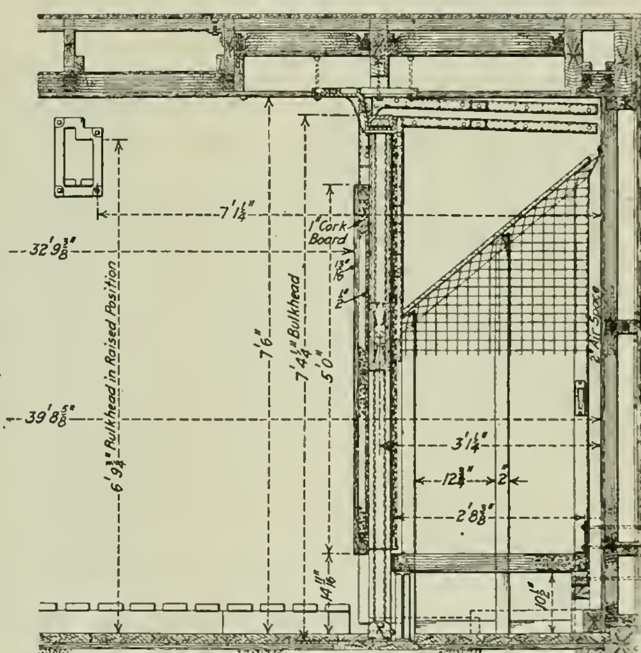
July 1, 1918, has been fixed by the Interstate Commerce Commission as the date after which the application of high-powered headlights to all locomotives must be carried into effect. Two years are allowed to complete the equipment. The order calls for the application of the headlights on all locomotives under construction after that date, as well as all locomotives that may pass through the shops for general or heavy repairs.

Burning Soft Coal.

It is well not to cover the whole fire at once. Do not load the furnace with coal. Do not carry the fire over twelve inches thick. Use the slice bar only when you have to; that is seldom. Don't turn the fire over when slicing. By all means avoid holes in the fire. Cover the fire only where it burns out, keeping it level. Keep the steam jet or other blower on for a minute after firing. Keep the ash pit empty, the boiler free of soot, and the water at the same height in the gauge glass all the time. Save coal.



END VIEW OF B. & O. REFRIGERATOR CAR.



END OF SIDE, SHOWING ICE BOX, BALTIMORE & OHIO.

Use of Wood in Railway Cars

The effect of heat and cold as regards their effects in lengthening or shortening or warping wood may practically be disregardend. The trouble experienced in using wood is almost exclusively caused by the presence or absence of moisture. This is entirely different to the effects produced by heat and cold and moisture on metals. Heat and cold manifestly affect them, moisture does not.

Wood is made up of cells, some of which lie with their length up and down the tree as it grew, other cells lie at right angles to the first, extending from the bark toward the centre. Those extending up and down are the most numerous, and the largest in size. All woods have these cells, and all woods have fibres running up and down the trunk. These cells are what draws when wood is drying, and this unbalanced pull may warp the wood or cause it to check.

To quote the Hardwood Record. When wood behaves in this manner it is doing nothing new. The handle of the stone hatchet of the paleolithic man warped as badly, and in the same way, as the axhandle of the modern lumberman. Wood has not changed. Modern methods of working it have not increased or lessened the material's natural tendencies to twist or pull out of shape. The modern boatbuilder who is compelled to reject a warped stanchion is confronted by precisely the same condition as faced Noah when he discovered that a king-post of the ark had warped and had pulled the rooftree out of line.

The stress is produced by the drying, and consequent shrinkage. When the water in green or wet wood goes out, the cells become smaller by the contracting of their walls. Every cell so shrinking pulls a little, and, such a force multiplied by millions, becomes strong enough to produce warping. A piece of wood contracts sidewise but not very much endwise. That is because the individual cells composing the piece shrink sidewise but very little endwise. The shrinkage of a plank or beam is only a multiplication of the shrinkage of individual cells or fibres. This is very readily seen by noticing how a hammer handle becomes loose in the head, while any alteration in its length produces no inconvenience for the user.

The vital problem in the use of kilns, is to so dry lumber that shrinkage is equally distributed throughout the parts. If not equally distributed, one part will contract more than another and warp the material or produce checks and cracks. Devices have been provided for extracting the moisture evenly from all parts of a plank so that stresses will be counteracted and the plank remain straight and without checks. Moisture from the interior of a piece of wood can come out only at a certain rate. Attempts to take it out too fast will cause shrinking in some parts, with checking and warping.

Veneer panels are built up of single sheets, the grain of the superimposed sheets crossing one another at right angles. That is done so that the pull of one shrinking sheet is in one direction, the next pulls at right angles so that one offsets the other, and the panel remains straight.

The question of cost also comes up as well as that of practical utility. One of our leading railways recently took this matter up and after going into it very thoroughly, came to the conclusion that a good substitute for mahogany must be found. Accordingly a competent man was assigned the duty of investigating the matter. Kitchen and pantry of dining and buffet cars and indeed other parts of these cars had been finished in mahogany.

It was decided at the mechanical staff meeting held by the officers of that department on this road, that the use of mahogany should be discontinued on all classes of wood work except in business cars and in dining rooms of diners and buffet cars. White wood was substituted for mahogany on all other parts of these cars except seat ends where birch was used. Birch doors were also ordered. A very substantial saving was promised by the alterations outlined here.

Changes of Names on P. R. R.

The Pennsylvania Railroad Co. has taken over the operation of the railroad lines west of Pittsburgh, which were heretofore operated by the Pennsylvania Company. These portions of the system will in the future be known as "The Pennsylvania Railroad Company; Western Lines." These lines were previously called the "Northwest System" and the "Central System." They constitute the direct main lines and the branches of the Pennsylvania System between Pittsburgh and Chicago. The Pittsburgh, Cincinnati, Chicago and St. Louis Railroad, commonly called the "Pan Handle," and embracing the "Southwest System," is not affected by this arrangement, but it will continue to be operated under its own name and organization.

General supervision over all departments of "The Pennsylvania Railroad Company, Western Lines," will be in the hands of Mr. J. J. Turner, with the title of senior vice president. Prior to the present arrangement, Mr. Turner was first vice president, Pennsylvania Lines West of Pittsburgh. The four chief departments of the Western Lines will remain in charge of the same vice president as heretofore, viz.: Mr. E. B. Taylor, vice president in charge of finance and accounting; Mr. D. T. McCabe, vice president in charge of traffic; Mr. George L. Peck, vice president in charge of operation, and Mr. Benjamin McKeen, vice president in charge of real estate and purchases. The headquarters for the Western Lines will continue to be in the Pennsylvania station at Pittsburgh, Pa.

Degrees of Curves.

On American railways, curves are always spoken of as being so many degrees. In other countries where English is spoken curves are described as being of so many feet radius. American railway engineers measure and describe a curve as part of a circle whose radius is established by the angle of deflection. If the angle of deflection is 1 deg. the radius of the curve will be 5,730 ft.; 2 degs., half of that, and so on. Consequently a 10-deg. curve is part of a circle having 573 ft. radius. It is easy to memorize the radius of a 10-deg. curve, and then a simple mental calculation will enable to tell approximately the true radius of any curve.

Another method growing in popular favor is the method of having railroad curves expressed in degrees and minutes of central angle subtended by a chord of 100 ft. Thus one degree of curvature being equal to a radius of 5,730 ft., hence $5{,}730 \times 2 \times 3.1416 = 360 \times 100$. Usually the slight error produced by measuring the distance as a straight line instead of an arc may be ignored, except in very sharp curves. The slight inaccuracies may be briefly stated as at 10 deg. the actual radius is 0.7 ft. longer; at 20 deg., 1.4 longer; at 30 deg., 2.2 ft. longer; and at 40 deg., 2.95 ft. longer than by the formula.

Oil-Saving Rules.

Use only closed oil cans, with spouts that will deliver drops, or at most only a thin stream. Use all lubricating apparatus strictly according to instructions and put the oil only where it will actually lubricate. If a machine has automatic droppers shut off the supply while machine is standing. Do not use cylinder oil on shafting or elsewhere when cheaper oil will answer. Keep all rubbing surfaces in good condition. Rough surfaces and too tight boxes consume more oil.

Worn and leaky bearings waste oil. Always use drip pans, and arrange to filter and cleanse the oil so caught. It is as good as new. Collect all greasy waste and wiping cloths, so that the oil may be recovered. Never burn them. Be careful about using lubricating oil for cooling a bearing. Water will often do as well. Be careful about using oil for cleaning and polishing. Never clean the hands with oil. A greasy cloth will do as well.

A great deal of waste takes place in shops where men take a preliminary wash-up with coal oil. There is no doubt that this is very effective and adds to their convenience, but it is waste.

Norfolk & Western Gondola

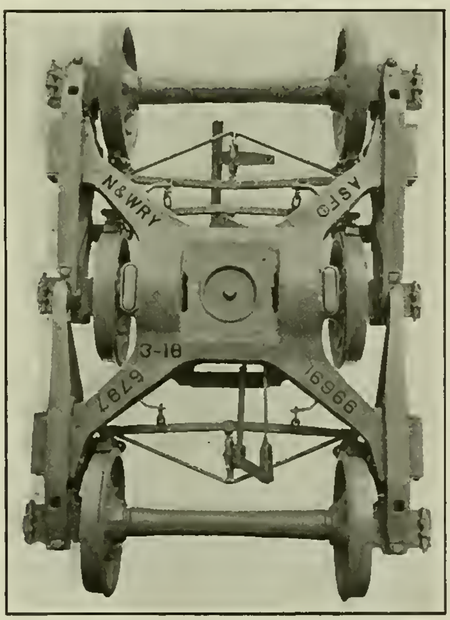
Long Car with Smooth Outside Appearance—Car Supported on Twelve Wheels—Lewis Truck—90 Tons Capacity; 29 Tons Tare

The Norfolk & Western Railway have recently put in service one thousand high, straight-side gondola cars for the carriage of coal and other rough freight when required. The company have built the cars at their own shops, like several other of our leading railways. The car shown in our half-tone is No. 101,393 and is a 90-ton capacity car. This railway has now some 1,716 cars of this capacity. Mr. W. H. Lewis is superintendent of motive power of the road.

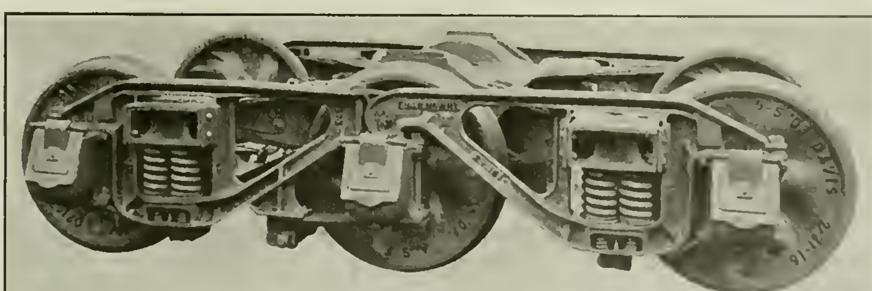
NORFOLK AND WESTERN HIGH SIDE GONDOLA.

The car shown is of the flat-bottom, gondola type, without drop doors, and is used in the company's own coal trade, the car being handled over the dumping machine at Lambert's Point. The car is built with inside side stakes and gussets, the outside being quite smooth. The bolster construction is unique, there are two bolsters at each end of the car and these are so arranged that the top flange construction of the bolster extends up into the cavity of the car. This has been done in order to give more depth for these bolsters, and also to avoid cutting the top flange members where they pass the center sills.

These cars are equipped with the Farlow single-key draft gear attachments. In this case the yoke is laid in a horizontal plane and abuts against a combined back stop and body bolster center casting, which is of cast steel. They are also equipped with the M. C. B. 6 x 8 ins. type "D" couplers with a 1½ x 5 ins. key. The N. & W. have in use on their several cars various different kinds of draw gear. The one shown in the half-tone is the Miner, A-18. The trucks are of the Lewis articulated, six-wheel type, as manufactured by the American Steel Foundries. The truck bolster is an integral steel casting of X-shape, there being a pair of rigid side frames to each truck and a pair of articulated side frames to each truck. The journal boxes are of the regular cast-iron M. C. B. pattern, and many parts of the truck are M. C. B. standard construction. Single type brakes are used, the brake beams being M. C. B.



TOP VIEW OF THE LEWIS TRUCK. NORFOLK & WESTERN.



LEWIS ARTICULATED SIX-WHEEL TRUCK, NORFOLK & WESTERN.

The volume of this car is 2,843 cu. ft. level full and 536 cu. ft. in a 30-deg. heap, or a total of 3,379 cu. ft. in all. The railway has had some of these cars in service for five years and the results got from them have been entirely satisfactory.

Of the 1,756 cars of this capacity in service the first sample one was built in 1912 and a second sample and also an order of 750 cars was completed in 1913. The successful performance of these led to the building of an additional order of 1,000 cars and of four additional sample cars of special design in 1915-1916. They have all been in service for a sufficient time to demonstrate their practicability, and the advantages gained in paying load, and in low train resistance or increased tonnage rating, together with lessened cost per ton of terminal handling. All these considerations fully justified and still justifies their use. The upkeep per car does not appear to be noticeably more than for lighter capacity cars, although it is reasonable to suppose that the attention to wheels, brasses and brake shoes would be increased in direct proportion to the number of them per car. The light weight of the cars of this design averages 58,300 lbs. The capacity painted on the outside is 180,000 lbs. and the cars are stencilled for wrought steel wheels. The car is 44 ft. long. The truck frames are hinged over the centre axle box so as to give flexibility of movement to the whole. The hinge joint at the centre also facilitates repairs and wheel changing. In our illustration the truck wheels are Davis cast steel 33-in. wheels. The ratio of paying load to tare weight is more than 3 to 1.

Babbitting Boxes.

Instead of using putty or clay for plugging up the ends of the boxes while the babbitt is being poured, some old asbestos pipe-covering may readily be ground up with cylinder oil to the consistency of a stiff putty. This mixture has these advantages: It is proof against the softening influence of heat, sticks far better to the box than either putty or clay, never "blows" when the hot metal comes in contact with it, and can be used over and over without loss or hardening.

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"Doing Our Bit."

An order has been received by the publishers of Railway and Locomotive Engineering for a thousand copies of Angus Sinclair's well-known work, now in its twenty-third edition, *Locomotive Engine Running and Management*. The order emanates from the Federal Government at Washington, and has been sent to us by the Baldwin Locomotive Works of Philadelphia.

Apart from the justifiable feelings of satisfaction and pride which this unsolicited order gives rise to, there exists in the mind of Dr. Sinclair, the author, the knowledge that the high endorsation his work has thus brought forth, will be shared by "our boys" in France, to whom the book is to be sent by the Government. It is intended that our American enginemen, working American locomotives on foreign soil, shall have the best means of gaining most useful, quick and practical help, and knowledge, in easily assimilated form, while "doing their bit" for the cause of Liberty in the devastated fields of fair France.

The book is too well known to require any detailed description here, suffice it to say that the difficulties presented by the air brake are smoothed away in its up-to-date pages. The book breathes the spirit of, and is in close touch with things as they are, without speculation and without the refinements of pure theory. The work comes from a man who has done the work he writes about, who has faced and overcomes difficulties and has succeeded. His experience and skill are put within easy reach of the learner, and the picking out of this work amid a host of others by the Government of our country, not only gives the engineman who follows close behind the firing line the best assistance of the kind in its power, but it confers another enviable distinction on its veteran author.

"'Quit You Like Men—Be Strong."

Railway and Locomotive Engineering does not as a rule go into financial matters, but confines itself to the presentation of technical subjects to its readers, which relate to the management and construction of locomotives and cars, appliances and devices, and such other railway matters as have a bearing on, or are involved in, these phases of railroading.

We have, however, had put before us the preparations which are being made to float another Liberty Loan, and it is only plain patriotism to call attention of our many readers to the laudable efforts which are being made in this direction. In the *Review of Reviews* for January, 1918, there appears an article on French Canada in which the author says it was a "monumental blunder," of the British government to have permitted the continued use of the French language. It may have been a mistake, but it was one of the heart and not of the head. To destroy the language would have been coercion. He very properly says that to speak English is eventually to think in the English way. This is true enough, but what underlies this is the fact that coercion in any form is distasteful to the Anglo-Saxon. He revolts at its application to himself and he refrains from imposing it on others. In leaving the language untouched, Great Britain refrained from even the pose of a conquerer.

The application of all this to the Liberty Loan, soon to be put on the market, is that the purchase of Liberty bonds is not compulsory. The appeal of the government is to a free people. The government states its needs for the war; it has defined the war aims of the country; for this is not, among the great democracies, a dynastic struggle. It is a peoples' war. In this the government is the peoples' agent and it is for the people to respond financially, if they want the work done efficiently and at once. The government places and sights the gun, but it is the people who pull the lanyard for the high and noble cause of Liberty.

The strength of the whole of this monetary campaign is that it is voluntary. Compulsion is foreign to the Anglo-Saxon mind; a thousand-fold happier is he who feels a duty has been voluntarily performed by him than that he should be told how to act. The men who now prepare for, and eventually buy, a Liberty bond feel a justifiable satisfaction which cannot be purchased; it cannot be valued in coin. Those who respond are protected financially, for the bond is emphatically a loan, bearing substantial interest and negotiable at any time. The man who now meets this high emprise in the true democratic spirit, laying politics and party gain aside, has raised himself fully up to the exalted level where a deep and heartfelt satisfaction is his present meed, and he has entered the nobler region where gold is not the currency.

These days are not bright, save only for the bow of promise which tells us that the sun still shines. We must not despair. The words of St. Paul have a special meaning for us today, "'quit you like men—be strong." The Liberty Loan affords a means to many of realizing the feeling and the knowledge of duty freely done, and again to quote the apostle to the Gentiles, let us say with him, "I have fought the good fight, I have kept the faith."

Saving Coal and Doing Other Things.

Reports which have been received from all divisions of the Pennsylvania Railroad (lines east of Pittsburgh and Erie) show that as a result of the reductions in passenger train service, made effective in January, 1918, the 104 week-day and the 51 Sunday trains which were taken off, has produced economies in motive power and man-power. Thus far the locomotives saved per day were 29, the locomotive crews saved per day were 55, the train crews saved each day were 47, and the train miles saved each year were 2,708,212.

The locomotives which have been saved are being used in part to replace others in the passenger service which are in need of repairs, and in part for moving the lighter forms of freight. The engine and train crews saved have been assigned to new duties in accordance with the seniority rules of the railroad. This is not merely a case of good men losing their jobs. In most cases the crews actually affected remain in passenger service, but the junior men, in the various grades of employment, on each division, have been transferred to other duties, either in the freight train service or elsewhere in passenger train service.

Thirty-five lines of parlor and sleeping cars were discontinued in the general reduction, each parlor or sleeping car taken off being replaced by one or more day coaches of approximately triple the carrying capacity of the freight equipment.

One more thing can be done, and very effectively done while the Government is in charge of the railways, and that is to look into the whole signal question.

There is no manner of doubt that a properly signaled road has had its capacity increased by that very fact. In this country reliable returns show that new railroads, are built in greater quantity than the signal systems on all lines are increased. In other words, the equipping of all roads, and the mileage protected by signals, has not kept pace with the growth of the total mileage.

On practically every British railway the Board of Trade regulations make the block system of signalling obligatory. The only exceptions are on what are called "Light" Railways, and branches where only one engine in steam is allowed; and even then the junctions are properly signaled and a staff or tablet is carried on the engine.

In this way the Government acting for the people put safety in traveling on the high and necessary plane on which it should stand. In our case, a board of experts on which practical railway men should have a place should go into the whole matter with the avowed purpose of doing something and not leave the question in the stage of simply an academic report.

It is right and proper and good business to save coal and conserve man-power, but at the same time increasing the capacity of the road seems to go hand in hand with it and to be logically related to it in the closest way possible.

Leaking and Freezing

Leaks between the tank and the injector are fatal to the working of the injector. A leak in the check valve between the boiler and the injector pipe is also a serious detriment to the operation of the injector. Leaks in the throttle valve or dry pipe are positively dangerous, by the former the full boiler pressure will in a short time reach the steam chests, and as both valves are never fully closed the pressure will reach one or both pistons, and the engine may move at a time when it is dangerous to life and limb. Leaks in the steam pipes not only affect combustion in the furnace, but waste steam, fuel and water. Leaks in sliding or piston valves or piston packing are equally deleterious. Even leaky cylinder cocks are not only wasteful of steam, but are a positive nuisance. The same may be said of the blower valve, gauge cocks and other boiler accessories, including the safety valves and the whistle.

When it comes to the air brake, with its many pipes and joints, which are mostly invisible, they are not discoverable by the inexperienced. If we add to this the heater pipes used in winter, and the electric conduits, which are pipes in the sense that they convey a "fluid" that seems to have a peculiar aptitude for leaking, the troubles multiply, and it is no wonder that the puzzled engineman is apt to think at times that the weaknesses incident to locomotive running and management are past finding out.

But this is not all. In mid-winter the troubles are doubled. If an engineman halts the locomotive four minutes to stop a serious leak, the chances are that something freezes, and figuratively speaking, a voyage into unknown seas has to be made to find out the frozen spot or spots. If the stoppage is prolonged, the north wind does its work, and pieces of ice a sixteenth of an inch in thickness in the bottom of the cylinder will hold the locomotive as still as if it were in the hands of a Titan, and the road is blocked, and the telegraph is buzzing and telephone bells are ringing soon after. Whether it is coal shortage or ammunition waiting delivery, the daily press makes caustic reference to the delay.

That there are remedies for the few troubles that we have referred to is known to the railroad fraternity, but a locomotive does not carry a machine shop, nor a special thawing apparatus; if it did, the conditions are such that it could not operate on all of the frozen appliances on the engine. The essential operations necessary to betterment call for experts just as a well-equipped hospital calls for medical experts familiar with the nature of accidents to the human body.

In these days, when the manifest effort of the railroad man and the lay man is to save coal, the allowing of steam leaks to uselessly blow away the energy contained in the fuel is highly reprehensible, to say the least of it. Much good work has been done by the technical press, by instructional pamphlets, and by lectures to bring clearly before the enginemen the waste that takes place by allowing pop valves to simmer or blow. The arguments used against this form of waste are practically applicable to all kinds of leaks.

The consumption of steam, even without leaks, is heavier in the winter than in the summer. In winter the boiler, the air pump, the exposed lengths of pipe, all readily radiate heat to the cold atmosphere. The necessity of blowing back steam into the water of the tender is practically a source of dead loss, because the necessity does not exist in the summer. The air entering through the ash pan and being used in the firebox enters at a far lower temperature than it does in the summer, yet it requires to be heated to the same service temperature in all seasons.

In winter a train of cars is harder to pull than it would be when days are warm, for the reason that oil becomes slightly thicker and does not readily flow, and even in the best days of the winter the rail usually has a more or less slippery coating of frost or snow. This coating, minute as it is, interferes with the motion of the train because it has to be crushed down or broken or shoved off the rail, and though no short stretch of track offers any great resistance, yet the cumulative effect mounts up, and its presence places one more obstacle to the movement of the train and gives the engine that much more work to do, and compels more coal to be burned to do it than it would if skies were clear and fields green.

The duty of engineman and fireman, and the duty of the round house in these days of war, winter and work is to make every endeavor to reduce the unnecessary use of coal by prompt single movement handling at the terminal and the stoppage of the many avenues of steam escape produced by the presence of small, insidious and often untended leaks.

Delay in Mail Deliveries.

The unusually large number of letters that come to us from the readers of RAILWAY AND LOCOMOTIVE ENGINEERING, complaining of the non-delivery of the periodical at the usual early part of the month induces us to take the opportunity to advise them not to trouble themselves writing to us too soon after the regular date of delivery. The delay is not with us, and while the Government claims that the delay to mails is entirely due to congestion of railroads, we are led to believe that there has been considerable congestion of mails in the post office, particularly about the advent of the new year, owing to the vastly increased volume of matter passing through the mails. Now that the Government has assumed control of the railways, it is possible that the mails may be expedited. In any event, the delay is not our fault, and we would ask that our readers generally and our subscribers particularly, would exercise their souls in patience, in view of the momentous conditions under which we live.

Not only so, but the additional holidays are affecting a large part of the industrial population as well as the manufacturers, who are not permitted to burn coal on Mondays, with the result that every fiber of our industrial system, including the distribution of mail matter, feels the retarding effect.

New High-Speed Steel.

A new high-speed steel has lately been patented in Europe. The patent specification states that the steel shall contain carbon, 1.2 per cent.; manganese, 1.2 per cent.; silicon, from 0.1 to 0.3 per cent.; chromium, from 3 to 10 per cent., and cobalt, 1.5 per cent. This material is said by the inventors to be an improvement upon a similar steel which they patented last year containing molybdenum. In its manufacture the molybdenum is omitted, and the percentage of manganese and chromium is increased.

Air Brake Department

Cleaning and Lubricating Brake Cylinders—Questions and Answers

Any reference to brake cylinder leakage from the viewpoint of the brake cylinder packing leather only, is necessarily incomplete for the reason that the leakage from a brake cylinder is not always through, or past, the packing leather, and in some cases the leakage is caused by some matter between the leather and the wall of the cylinder, for which the leather itself is in no wise responsible.

Regardless of what may have been said with reference to porosity of leathers, re-testing or re-filling, some consideration must be given the cleaning and lubricating of the cylinder if satisfactory results are to be obtained with any kind of leathers or cups, and in the following an effort will be made to set forth what is generally conceded to be good practice in performing any work on a brake cylinder.

In cleaning a brake cylinder, kerosene or carbon oil may be used for removing the dirt and rust from the wall of the cylinder and waste may be used for applying this oil and removing the dirt, but the final wiping should be done with rags, to prevent particles of waste or lint from remaining in the cylinder and working in between the leather and cylinder and causing leakage. The leakage groove also should be cleaned when the cylinder receives any attention on the interior.

The accumulation of heavy bodied grease should be removed from the piston with a wooden scraper, and carbon oil may be used for cleaning the piston and follower plate, provided that it does not touch the packing leather; if it does, it destroys the filler that is placed in the leather by the manufacturer, and the result is a leaky leather, for the reason that this filler has been forced into the leather for the purpose of making it what is termed air tight. If a leather is too hard or stiff to permit the expander ring to hold it against the cylinder it should be removed, but not necessarily destroyed, as the leathers can be retreated at a comparatively small cost per leather. However, in ascertaining the pliability of the leather, it must never be rubbed together or crumpled up for the purpose of softening it, as the bending or rubbing breaks and destroys this same filler and also causes the leather to leak.

One of the most prolific sources of brake cylinder leakage, especially on locomotives, is past the studs holding the follower plate on the piston, and in many instances it is caused by the stud screwing out of the piston when an attempt is made to remove the nut from the stud. If, in renewing a leather, one of the studs backs out of the piston, the nut should in all cases be removed and the stud tightened into the brake piston, using red or white lead, before the follower plate and leather are bolted in place on the piston. What, in many instances, contributes to leakage past these studs in the piston is the fact that the studs are ½ inch and 12 threads per inch and some one has attempted to use a standard ½-inch stud or one of the 13 threads per inch, and in consequence has ruined the threads in the piston. The nuts and studs specified by the manufacturer should in all cases be maintained in stock and be used for the purpose for which they are intended, and it will be found to be a decided advantage to have ½-inch 12-thread taps and dies for this purpose even if used for no other. It is obvious that no matter how tightly the stud screws into the piston a damaged thread will cause leakage, brake cylinder leakage, that cannot be remedied by the application of any kind of a leather or cup. When threads in the piston are found to be damaged, the piston should not be used until it has been repaired, which may be done by making a special stud or by bushing the hole in a manner that a standard-sized hole with a perfect thread can be obtained.

The condition of the expander ring is also of the utmost importance, and in all cases where a packing leather is removed, the expander ring should be gauged before being returned to service, and contrary to some previously accepted theories, the ring should not conform to the circumference of the cylinder, but rather to a cylinder ⅜-inch less in diameter than that of the brake cylinder the ring is to be used in. Such a gauge may be manufactured without any difficulty, and when a ring is compressed and placed in it, it should conform to within 1/32-inch all around and the ends of the ring should be from 1/32-inch to ¼-inch apart. The position of the ring will at this time approximate the position it is in when inside of the leather in the cylinder.

It is also quite evident that a cylinder may be worn, especially one in which the brake piston works on a horizontal plane, and when this is found to be a fact, the wear is usually at the bottom of the cylinder, caused by the weight and wear of the piston. Under such circumstances we know of no repairs that can be made outside of renewing the cylinder. Another thing that contributes to brake cylinder leakage is a badly worn non-pressure head, at the point at which the piston passes through it, and this part, as well as a badly worn piston rod or release spring, should be renewed when excessive lost motion or wear develops. In some shops the non-pressure heads are repaired by rebushing the worn hole.

There should be some hard and fast rule laid down for the lubricating of brake cylinders, and it should be enforced to the letter. The particular kind and amount of lubricant to be used will depend somewhat upon local conditions, but an excellent practice is to limit 8 and 10-inch cylinders to 4 ounces; 12 and 14-inch cylinders to 5 ounces, and 16 and 18-inch cylinders to 6 ounces, which if adhered to will prevent a waste of lubricant, and what is much worse, the possibility of any of it working back into the triple valve or other car brake or locomotive brake operating valve.

It is interesting to note in this connection that one railroad at least has considered brake cylinder leakage, or the elimination of it so far as possible, to be of sufficient importance to build brake-cylinder packing leather test racks and install them in shops, so that instead of applying the leather to the piston at the car in the yard, the leather is applied in the shop, and the piston and leather are placed on the test rack, composed of brake cylinders of various sizes, and the leakage in pounds per minute is ascertained, and if not in excess of a specified amount, the piston and leather attached is placed in a protection casing or container and transported to the car.

It may be of assistance to quote the following from certain standard instructions governing the application or replacement of a brake cylinder piston: "When replacing the piston in the brake cylinder, care must be taken to keep the expander ring between the packing leather and the follower plate, and the opening of the expander ring when placed in the cylinder at the top, one-quarter away from the leakage groove; also that portion of the packing leather that had before been at the bottom of the cylinder is now turned to the top of the cylinder. When the piston head and leather have been well entered into the cylinder, the end of the piston should be raised to a horizontal position, at the same time pulling it out slightly to prevent the leather from turning in the wrong direction. Sharp tools must not be used to help enter the packing leather. After the piston is entered into the brake cylinder it can be ascertained whether the expander ring has worked out of position by moving the end of the piston so as to describe a circle of about 8 inches in diameter. If the ring is out of place this cannot be done, as the piston will stick."

Locomotive Air Brake Inspection.

(*Continued from page* 19, *January,* 1918.)

185. Q.—Should a further reduction in brake-pipe pressure be made at this time?

A.—Yes.

186. Q.—How much and for what purpose?

A.—Enough more to bring the brake-pipe gauge hand below the brake cylinder hand.

187. Q.—Why?

A.—To see that there is no back leakage from the brake cylinders into the brake pipe, if the distributing valve is equipped with a quick-action, equalizing cylinder cap.

188. Q.—How could air enter the brake pipe from the brake cylinders?

A.—If the brake cylinder check valve of the quick-action cap is leaking, air from the main reservoir could flow through the brake cylinders into the brake pipe when brake-pipe pressure has reduced below brake-cylinder pressure.

189. Q.—What would at this time occur if the check valve was leaking?

A.—A heavy blow would start at the brake-pipe exhaust port of the automatic brake valve.

190. Q.—Is this a serious defect of the brake?

A.—It might never be discovered with the engine in passenger service, but it might have serious results if the engine went into freight service in this condition.

191. Q.—How?

A.—With the lower brake-pipe pressure carried in freight service, a 25-lb. brake-pipe reduction would result in at least an equalization of pressure; then brake-pipe pressure becoming lower than brake-cylinder pressure with the result mentioned would cause a loss of main reservoir pressure and possibly a release of some of the brakes in the train at a time when all the braking force available is required.

192. Q.—Continuing the inspection, after this brake-pipe reduction what should be done?

A.—The brake should be released with the independent brake valve.

193. Q.—For what purpose?

A.—To know that the locomotive brake can be released independently of the train brakes.

194. Q.—At what time would such a release be desirable or necessary?

A.—In the event of driving wheels picking up and sliding at a time or under conditions where the train brakes could not be released without incurring the liability of a run-by or an accident.

195. Q.—What would likely result if an engine was allowed to run with the brake in a condition that the brake could not be released and leave the train brakes applied?

A.—Slid flat driving wheel tires or overheated and loosened tires.

196. Q.—What would be wrong if the independent brake could not be released under the conditions being considered?

A.—The exhaust port of the independent brake valve might be stopped up or the application cylinder and release pipes would be wrongly connected either at the distributing valve or independent brake valve.

197. How can the difference be told without tracing the pipes, or examining the exhaust port of the brake valve?

A.—By moving the automatic brake valve handle to holding position, then moving the independent brake valve handle to release position.

198. Q.—Will the engine brake then release if the application cylinder and release pipes are wrongly connected?

A.—Yes.

199. Q.—Will the brake then release if the exhaust port of the independent brake valve is closed?

A.—No.

200. Q.—Could anything else prevent the release of brakes under this condition?

A.—Yes, a stopped-up application cylinder pipe.

201. Q.—Is this liable to happen?

A.—It has happened, but the disorder does not exist for any considerable period of time.

202. Q.—Why not?

A.—Because the independent brake could not be applied at any time with the application cylinder pipe stopped up.

203. Q.—How long should it take to exhaust application cylinder pressure down to 5 lbs. or less under the conditions mentioned?

A.—From 2 to 3 seconds.

204. Q.—What if it takes considerably longer than this time?

A.—It indicates some partial stoppage in the application cylinder connections usually found in the ports or cavities about the equalizing slide valve bushing of the distributing valve.

205. Q.—After this test what is the next brake valve movement?

A. The brake valve is moved to release position.

206. Q.—For what purpose?

A.—To overcharge the pressure chamber of the distributing valve reservoir, or to about 125 or 130 lbs.

207. Q.—How long should this take?

A.—Somewhat over a minute, the pressure chamber pressure having been considerably reduced from the previous operation.

208. Q.—What should be observed in connection with the ports of the automatic brake valve at this time?

A.—That the warning port is open and discharging air through the direct exhaust port.

209. Q.—How does the time of charging the distributing valve reservoir compare with that of auxiliary reservoirs?

A.—It charges uniformly with them.

210. Q.—Why?

A.—The feed grooves of all operating valves are proportioned in size to the reservoirs they are required to charge from the brake pipe.

211. Q.—Why is uniform rate of charging or recharge desirable?

A.—To produce as nearly as possible uniform applications of brakes, when applications follow each other with very little time elapsing between brake applications.

212. Q.—What else should be done while the brake valve is in release position?

A.—The hands of the air gages should be compared.

213. Q.—What pressures should the black hands and red hand of the large gage register?

A.—They should register the same pressure.

214. Q.—Why?

A.—Because main reservoir, equalizing reservoir and brake pipe pressures are equal.

215. Q.—What will indicate that the black hands are registering correctly?

A.—They were compared with the test gage when entering the cab.

216. Q.—How is it determined whether the brake cylinder gage hand is correct?

A.—During the independent brake valve test.

217. Q.—During this comparison, what is wrong if the red hand of the large gage registers more or less pressure than the black hands?

A.—The red hand is not registering correctly.

218. Q.—What is wrong if the black hand of the large gage registers 110 lbs., the black hand of the small gage 105 lbs., and the test gage 110 lbs.?

A.—The black hand of the small gage is out.

219. Q.—How are the locomotive gages sometimes indicated?

A.—As the No. 1 and No. 2 gages.

220. Q.—Which is the No. 1?

A.—The large gage.

221. Q.—What would be wrong if the test gage shows 105 lbs. and the engine gages 110?

A.—The engine gages are wrong.

222. Q.—How do you know that the test gage is not wrong?

A. If it was it would show wrong with all other engines.

223. Q.—What would be wrong if the test gage and both engine gages showed 105 lbs. and the main reservoir pressure was 140 lbs.?

A.—The feed valve would be improperly adjusted.

224. Q.—When should a feed valve be adjusted?

A.—When it is out of register 3 lbs. or more.

(*To be continued.*)

Train Handling.

(*Continued from page 20, January, 1918.*)

202. Q.—What would cause the reduction necessary to apply these brakes?

A.—The flow of brake-pipe air to the uncharged cars at the rear of the train.

203. Q.—Why not leave the brake valve in release position for a period of less than 15 seconds?

A.—Because it requires about this length of time to force all of the K triples possible to retarded release position.

204. Q.—Why is it desirable to have them in retarded release position?

A.—To hold the brakes applied and prevent any rapid run out of slack while the rear brakes are releasing.

205. Q.—Do the reservoirs at the head end charge as rapidly when the valves are in retarded release position?

A.—No.

206. Q.—Why not?

A.—Because one of the feed grooves is closed in this position.

207. Q.—For what purpose?

A.—To produce a uniform recharge of auxiliary reservoirs through a smaller charging port from the higher brake-pipe pressure at the head end.

208. Q.—Why will a 5-lb. brake-pipe reduction cause an application of all of the brakes in a train if they are K valves, but will not all apply on a long train with H triple valves?

A.—Because K triple valves have quick service features whereby each valve makes a local brake-pipe reduction as it moves to application position, thus continuing the brake-pipe reduction throughout the train.

209. Q.—Where does this brake-pipe pressure vent?

A.—Into the brake cylinders of the cars.

210. Q.—What might be the effect of a very heavy overcharge of the head auxiliary reservoirs on a long train?

A.—It might result in undesired quick action.

211. Q.—On which cars?

A.—On those at the head end of the train.

212. Q.—Why not on the rear ones?

A.—They will not have recharged sufficiently.

213. Q.—What will be the probable effect of quick action on only the head cars of a long freight train?

A.—A buckling and wrecking of the train if conditions happen to be right.

214. Q.—How is the brake-pipe reduction necessary to produce quick action under this condition obtained?

A.—Through the rapid flow of brake-pipe air to the rear cars before the auxiliary reservoirs on them have had time to become fully charged.

215. Q.—When does this heavy application on the head cars take place after a release?

A.—When the brake valve handle is brought to running position.

216. Q.—What does this do to a brake pipe that is charged beyond the adjustment of the brake-pipe feed valve?

A.—It cuts off the supply from the main reservoir to the brake pipe.

217. Q.—Why?

A.—Because the feed valve cannot open until the brake-pipe pressure is below the tension of its regulating spring.

218. Q.—What will usually occur at the head end, even if the brake valve is not allowed to remain in release position for more than 20 seconds?

A.—There will be a reapplication of the head brakes when the brake valve is brought to running position.

219. Q.—Is this desirable?

A. No, but it cannot be avoided, if the brake valve is held in release position long enough to insure a release of brakes on the rear cars of a long train.

220. Q.—How are these brakes then released on the head cars?

A.—By a second short movement to release position about 10 or 15 seconds after the return to running position.

221. Q.—What causes the compressors to stop at this time?

A.—The action of the excess pressure governor top.

222. Q.—How can the compressors be kept in operation?

A.—By moving the brake-valve handle partly to release position.

223. Q.—Is this generally recommended?

A.—No.

224. Q.—Why not?

A.—Because of the liability of overcharging the brake pipe excessively.

225. Q.—Can this movement be made and the compressors be kept in operation by a man who thoroughly understands what he is doing?

A.—Yes. With a little practice the amount of pressure admitted to the brake pipe can be regulated in a manner to keep the compressors in operation and accomplish a release of brakes in the shortest possible space of time.

226. Q.—What is required to release the rear brakes on long trains?

A.—A driving head to force the compressed air back to the brake pipe at the rear.

227. Q.—What is this driving head?

A.—Excess pressure, or the difference in pressure in the brake pipe at the head and rear end of the train.

228. Q.—Is it, then, possible to have a vast difference in the pressure in the ends of the brake pipe on a long train?

A.—Yes; it is not unusual to have over 100 lbs. pressure in the brake pipe of the head cars during a release of brakes and less than 50 lbs. pressure in the brake pipe of the rear cars.

229. Q.—Do you know of a more extreme example?

A.—Yes; with large capacity air compressors it is possible to pump up the standard brake pipe pressure on the engine with the angle cock at the rear end of a long train open.

230. Q.—About how long would it take for compressed air under 110 lbs. pressure in the main reservoir to flow through the brake pipe on a 100-car train and issue from the angle cock at the rear end?

A.—About 20 to 25 seconds.

231. Q.—Under brake-operating conditions, about how long would it take for compressed air to flow from the main reservoir to the rear of the train and release brakes?

A.—At least one minute.

232. Q.—And under unfavorable condi tions as to leakage and small capacity compressors?

A.—It might require two minutes, or even more, to make any noticeable increase in the brake-pipe pressure on the rear cars.

233. Q.—After an ordinary brake application, how long would you wait after moving the brake valve handle to release position before moving the engine throttle to start the train?

A.—At least one minute and a quarter.

234. Q.—What would be expected to happen if the brake valve was moved to release position and the engine brake was released with the independent valve and the engine throttle opened about 15 seconds after the movement to release position?

A.—If the locomotive was powerful enough to get away there would likely be two or three sections of the train left.

235. Q.—Why would the train likely break in more than one place?

A.—Because the first break would occur near the point where the brakes were still applied; then quick action would likely take place at the rear of those cars on which the brakes had released, and possibly cause one or more breaks-in-two.

236. Q.—Why does quick action emanating from the rear of a train usually result in a break-in-two?

A.—Because the rear of the train usually stops while the head end is still in motion.

237. Q.—How long would you wait before opening the engine throttle after a brake application if the engine had been cut off from the train for some time?

A.—It would depend somewhat upon the pump and main reservoir capacity of the locomotive, and the pressure shown on the brake- pipe gage after coupling the air hose.

238. Q.—How long, with proper pump capacity, even if the pressure was considerably depleted?

A.—From 2 to 3 minutes.

(*To be continued.*)

Car Brake Inspection.

(*Continued from page 21, January, 1918.*)

209. Q.—Why is it not uniform?

A.—On account of the brake valve of the locomotive feeding air into the brake pipe at one end of the train while the pressure is reducing in the brake pipe near the back-up hose connection.

210. Q.—How are these instructions usually varied?

A.—By local conditions governing the various shifting movements.

211. Q.—In case of a broken brake pipe what can be done to keep the car moving to a point where the pipe can be repaired?

A.—The signal pipe can be used on that car to connect up the brake pipe on the cars ahead and behind it.

212. Q.—In what manner?

A.—By connecting the brake and the signal hose couplings.

213. Q.—Can this be done?

A.—Yes, but it is sometimes necessary to hammer them together.

214. Q.—What should be done with the hose couplings after they are then parted?

A.—The hose should be removed and the couplings be gauged before they are returned to service.

215. Q.—For what purpose?

A.—To ascertain if they have been injured through the hammering together.

216. Q.—Have air hose ever been known to be obstructed?

A.—Yes; such things as hose linings obstructing the hose have occurred, but it does not occur with hose of modern manufacture.

217. Q.—How is the freight triple valve distinguished from the passenger triple valves?

A.—The freight triple valves usually have two exhaust ports, while the passenger valve has but one.

218. Q.—How may they positively be distinguished?

A.—By the bore of the slide valve bushing and the bolt holes in the flange.

219. Q.—What is the bore of the slide valve bushing of the H-1 triple valve?

A.—1¼ inch.

220. Q.—What is the bore of the slide valve bushing of the P-2 valve?

A.—1¾ inch.

221. Q. The bore of the H-2 and P-1 valves?

A.—1⅜ inch.

222. Q.—How may these two valves then be distinguished?

A.—By the fact that the H-2 valve has three bolt holes in the flange and the P-1 has but one.

223. Q.—How are the K valves distinguished?

A.—By a fin on the back of the valve, placed there for the purpose of distinguishing them from H valves.

224. Q.—What important difference is there in the graduating springs of freight and passenger triple valves?

A.—The passenger valves have a heavier spring.

225. Q.—Can you describe the spring of the passenger valves?

A.—It is of 13½ coils and of 8/100 nickeled steel wire.

226. Q.—What is the freight spring?

A.—Of 15½ coils, and the wire is 58/1000 in diameter.

227. Q.—In what other way may the springs be distinguished?

A.—By their length or free height; the freight triple valve spring is 2¾ inches and the passenger spring 2⅝ inches.

228. Q.—How are the freight triple valves used with different sized equipments?

A.—The H-1 and K-1 valves are used with 8-inch equipments and the H-2 and K-2 with 10-inch equipments.

229. Q.—In the event of making up a car in a train that does not happen to be equipped with a high-speed reducing valve, and the brake-pipe pressure is 110 lbs., what should be done?

A.—A safety valve set at 60 lbs. should be screwed into the brake cylinder.

230. Q.—What if one cannot be obtained?

A.—The engineer must be notified of the condition.

231. Q.—Should he reduce the brake pipe pressure on the train?

A.—No; he will remember this condition when applying the brakes.

232. Q.—What could be wrong if an emergency application of the brake was made and when the brake valve handle was placed in release position the brakes failed to release and one car was found where there was a heavy blow of air from the triple valve exhaust port?

A.—The emergency valve of that triple valve would be off its seat.

233. Q.—What could be holding it off?

A.—An obstruction on the seat, but more likely the emergency piston has stuck in the bushing.

234. Q.—What could be done to reseat the valve?

A.—The brake-pipe stop cock could be closed and the auxiliary reservoir bled and the valve again cut in quickly, which might seat the valve.

235. Q.—Should such a valve be allowed to continue in service?

A.—No; it might again stick open and cause an unnecessary delay.

236. Q.—What should be done if the engine couples to a train and quick action of brakes occurs when a service application is attempted?

A.—A test must be made to locate the defective valve.

237. Q.—How?

A.—By closing an angle cock in the middle of the train and trying the brakes on the forward portion.

238. Q.—What would be done if the brakes did not then work in undesired quick action?

A.—Release and recharge thoroughly and cut in some more cars until the defective valve were traced down to a certain number of cars.

239. Q. As an example: If the train contained 20 cars and quick action developed after five cars were added to the first 10 that were tested and found to be working in service, what would be the most positive way in which to locate the defective valve?

A.—By requesting the engineer to make a five-pound brake pipe reduction and watching to see which brake did not apply.

240. Q.—What would the brake not applying indicate?

A.—The defective or "sticky" triple valve.

241. Q.—Is there a more positive way to locate the defective valve if it becomes difficult to locate?

A.—Yes, by first closing the brake-pipe stop cocks in the branch pipes leading to each of the suspected triple valves, then signaling for the release of brakes. After the release of all other brakes, the stop cocks should be opened very slowly to a point where the triple valve receives enough brake-pipe pressure to effect a release; then, after waiting a reasonable length of time for the reservoirs to become fully charged, signal for another application of the brake.

242. Q.—What can be expected during this application?

A.—Only the defective valve can work in quick action.

243. Q.—Why?

A.—Because the cut-out cocks are so nearly closed that when the triple valve kicks or "dynamites," it can only go into quick action itself, as it cannot reduce brake-pipe pressure through the restricted opening in the cut-out cock at a sufficient rate to produce quick action on the rest of the cars.

244. Q.—How will the valve then act after it has applied in quick action under the conditions mentioned?

A.—It will release a few seconds afterward.

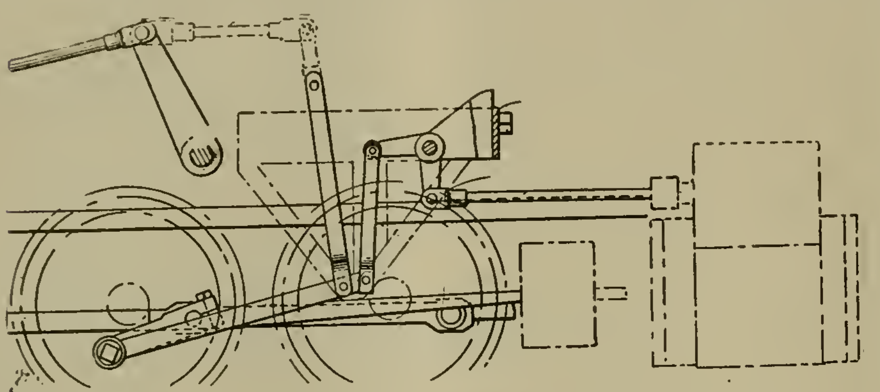
245. Q.—What will cause it to release?

A.—Assuming that 8 or 10 lbs. brake-pipe reduction has been made, the brake-pipe pressure will be very nearly the maximum, but the valve that works in quick action will equalize the brake cylinder and auxiliary reservoir pressure at a much lower figure than the pressure in the brake pipe, and the brake-pipe pressure will at once flow into the check valve case of the triple valve through the restricted cut-out cock, and in a few seconds' time the brake will release through the triple valve exhaust port.

(*To be continued.*)

New Design of Locomotive Valve Gear

As we have stated before, perfection eludes and ever will elude the seeker after the ideal. No better proof of this fact can be found than in the ever-recurring appearance of a new valve motion. The present century has seen quite a crop blossom into being on the American locomotive. The adoption of the Wakehaerts' gear was followed by the Baker-Pilliod, the Southern, the Young,



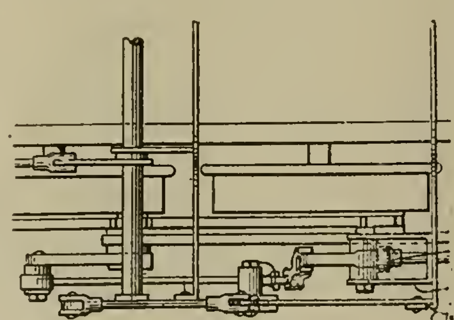
SIDE VIEW OF THE SMITH VALVE GEAR.

and others, all stamped by some peculiarity, and all meeting with more or less approval as compared with the old shifting link or Stephenson valve gear as it is generally called. Last month another contrivance appeared before us. It is the invention of W. L. Smith, Tuscumbia, Ala. The design is marked by simplicity. The absence of the sliding or oscillating link, so common in radial gears, gives promise of durability, as the wearing parts are few and may readily be made substantial, the appliance may be attached to different types of locomotives and reversing engines, without necessitating any material change in the construction of the engine to which it is to be attached.

Our illustrations show a side elevation and fragmentary top plan. It will be noted that an auxiliary crank is attached to the main driving pin, the auxiliary crank being coupled to an eccentric rod. A frame, consisting of transverse bars, is mounted on the locomotive. Plates and bars sustain the frame. On the bars nearest to the steam chest there is a U-shaped bracket in which a bell crank is journaled, and connected pivotally at one end with the outer end of the valve rod or stem, and at its other end is pivotally connected to one end of a substantially upright link. The link is connected at its lower end with the eccentric rod, at the extreme end of the eccentric rod. The ends of the bell crank are bifurcated to receive the ends of the bell crank and eccentric rod.

A tumbling shaft securely mounted on the frame extends to a point flush with the plates of the frame. A reach rod is connected to an arm of the tumbling shaft at a point spaced from the ends of the tumbling shaft, and at its other end is connected with the usual reversing lever in the cab of the locomotive. An auxiliary reach rod is connected at its ends with the end of an arm of the tumbling shaft, and an apertured extension that is formed on the end of a tumbling shaft reverse yoke. This yoke is U-shaped and straddles the plates on the frame. The lower ends of the sides of the yoke are pivoted to the frame and serve to support and properly guide the tumbling yoke, the arms of the yoke being arranged upon opposite sides of the plates.

A radius bar or link is pivotally con-



PLAN VIEW OF SMITH VALVE GEAR.

nected with the eccentric rod at a point slightly spaced from the connections of the upright link previously alluded to. This radius bar or link is approximately upright and connected at its upper end pivotally with upper arm of the bell crank, the lower arm as already stated, being attached to the valve rod. The radius bar, being supported by the tumbling yoke, it will be readily seen that by moving the reverse lever the tumbling yoke will be moved in an arc, and in so altering moves the radius bar link in such a way that the eccentric rod is caused to change its position and the reversing of the valve is resultant.

Such is a brief description of the new valve gear, and it is claimed that by taking advantage of the rapid movement of the crank and eccentric rod at the lower and upper parts of the stroke of the crank a quick opening and closing of the valve is obtained with a reduced velocity when the valve is fully opened. The dimensions of the parts, of course, are such as are readily adaptable to the general dimensions of any locomotive, and as the parts are few in number, the cost of construction would consequently be correspondingly less than a more complex mechanism, not to speak of the comparative ease in assembling or disassembling the parts.

Boiler Management.

Quite recently Mr. C. E. Stromeyer, the chief engineer of the Manchester (England) Steam Users' Association, made some remarks on boiler management, a great deal of which is applicable to locomotive firing. He said in part:

While the fire door is open, there is practically no combustion on the grate and relatively little heat comes from the coal on the grate. A distinct loss of heat is caused by the rush of cold air through the furnace and flues, as this cold air takes heat from the brickwork and the plates. This is a serious matter. The cold air which comes in at the open door has not to overcome any resistance as it passes over, not through a thick bed of coal. It travels with great velocity and its weight will be from 50 to 100 times (say 50 times) the weight of the coal which would have been burnt in the same time if the door had not been open.

If the average supply of air is 15 lbs. per pound of fuel burnt, then for the combustion of 1 lb. a minute we have a total supply of 15 lbs. x 13 mts. = 195 lbs. and say 50 lbs. x 2 mts. = 100 lbs., making a total of 295 lbs. in 15 mts. (door opened every quarter hour for 2 mts.) for the burning of 13 lbs. of coal or nearly 20 lbs. of air, instead of the theoretical 15 lbs. The minimum loss through the stack with a waste gas temperature of 500 degs. Fahr. above the atmosphere is about 1.5 per cent. If the weight of the waste gases is increased to 20 lbs., the loss is 20 per cent (about). If it is increased by poor firing to 30 per cent, the loss mounts up to very serious figures. If a careless or inexperienced fireman keeps the door open 3 or 4 mts. instead of even 2 mts., he will easily exceed the 30 lbs. of air per pound of fuel burnt.

Roughly speaking, every 2 mts. the door is open means a loss of efficiency which may reach 5 per cent, and the power of the boiler is reduced by about double the ratio of open to closed-door time. Not only is there no steam production from the furnace when a door is opened, but the cold air of the furnace actually ab-

stracts heat. One of the chief reasons why mechanical stokers are economical is because with them the doors are never opened except for raking or similar purposes.

The man who may be watching the fireman will soon discover that the more quickly the firing is done the more easily can steam be maintained, but only if the firing is properly done. Suppose that the coal is thrown on the grate anyhow; then, as there is less resistance to the passage of air at the thin parts than at the thick ones, the latter hardly burn away at all, while the former burn themselves first into pockets and then into holes, and long before the next firing is done there will be a rush of cold air through these holes. This unfavorable condition has, of course, to be remedied by raking, but that operation introduces cold air and results in a diminished steam production and a reduced efficiency.

It would, however, be wrong to forbid the raking of the fires or the opening of the doors. Some coals must be broken up, and some coals, because they produce smoke, must be supplied with air through the doors. This latter air supply has to be regulated by studying the smoke discharged from the stack. If it is black or dark, then the air supply through the firedoor is insufficient; if there is no smoke, then there is an excess of air either through the door or through holes in the bed of the fuel, or through the bed of fuel if this is too thin.

The question of thickness of fire is a somewhat complicated one. Let it be assumed that the fuel on the grate is very thin, then much air will pass through it. Of this air only a small portion will come in contact with the coal, and will escape without causing combustion. The result will be a relatively large volume of waste gases, and the efficiency, or the steam production, and the draught will be low. If the thickness of the coal were to be increased this should result in perfect combustion and high duty, even though this thickening increases the resistance to the air and reduces its flow. Any additional thickening will still further reduce the air supply, but as this reduction is associated with the evolution of combustible gases, the total quantity of coal consumed will be increased. But the gas which now escapes is partly combustible, and would carry away much potential heat. Here, however, perfect combustion can be effected over the bed of fuel by admitting air through the door and mingling it with the escaping gases.

Now, it is evident that immediately after firing, when the bed of fuel is thick, a comparatively large quantity of air should be admitted through the fire door, but gradually, as the bed of incandescent fuel on the grate is reduced, and as more and more air passes through it, the air supply through the door should be restricted. The ideal conditions would be to pile so much coal on the grate that at first there is what might be called perfectly incomplete combustion, and never to let the fire burn itself so thin that excess air can pass through. The study of this subject will take time, for the reason the man watching the stoking operation should decide to devote a day or two to it. He will find that, because of the steadily increasing bulk of clinker on the grate, the thickness of a fire at the end of the day is only apparent. The flow of air is then restricted by the clinker even more than by coal of the same thickness, and therefore, as the fire gets dirtier and dirtier, the production of combustible gases grows less, and the air admission above the bars has to be decreased. These changes can be balanced by altering the positions of the dampers, unless these are already full open because the boiler is over-worked.

Seeing that both steam production and economy are affected by the thickness of fuel on the grate, an onlooker will be interested to study the extremes of thin and thick fires. Thin fires, as already mentioned, allow too much air to pass through the fuel without burning it. The heaviest steam production would take place when the maximum amount of air passes both through the fuel and through the door, provided that it is completely used up. The best condition varies for different coals and for different conditions of the bed of fuel. Suppose that this best condition has been found with the fire door, say, half open. Then, if we thicken the bed of fuel, we reduce the flow of air through it, but we increase the relative amount of combustible gases, and the door can perhaps still be kept half open, the efficiency is likely to be the same as before, but as the amount of perfect combustion in the bed of fuel has been reduced, the steam production will also have been reduced. If now we increase the thickness of the fuel still further, both the perfect and the imperfect combustion in the fuel will be reduced, and the door will have to be partially closed, unless the space over the fuel has a smaller sectional area to that of the half-open door. In that case, of course, the door will have to be kept full open. Under these conditions the power will have been reduced, but not the efficiency. If the thickness of the fire be still further increased, insufficient aid will enter above the grate and both the power and the efficiency will be reduced.

Here it must be understood that Mr. Stromeyer is speaking of conditions of stationary boiler firing, but it serves to show the importance on a locomotive, of keeping the door shut. The best conditions of working are evidently too vaguely defined to be determined by trial and error. A more rapid determination can be made by purposely working under extreme conditions of thin and of thick fires, and then adopting the mean condition as being probably the best.

Roughly speaking, coals can be divided into caking and non-caking. The latter break up while burning, and, if disturbed by raking, they fall through the grates, and the result is much waste. Coal of this class should therefore be thrown evenly on the grate, and should not be disturbed. Considerable manual skill and a good eye are required to do this work properly. Caking coal must be broken up after it has become heated and stuck together. Caking coal produces smoke, and that has to be avoided. The general practice with this coal is therefore to throw it on to the front end of the grate. Then this mass of coal is broken up with a rake and shoved back, the fire door being closed some time after. Another method, called side firing, is equally effective in preventing smoke. The firing interval is divided into two short ones and during the one opening of the door the fuel is thrown only on the one side of the grate, and during the next on the other side. The smoke which is produced on the newly charged side is consumer as it passes to the other side.

In ordinary times, it is, perhaps, not necessary for managers to trouble about steam production, if one fireman cannot maintain steam, or if he burns too much coal for the steam produced, he can easily be replaced. Today, however, replacements are not easily effected, and the substitutes who have taken the place of reliable firemen have to be guided into methods of firing which will give the best results.

Bad results are, however, not always due to the fireman; in many cases the inspection and cleaning of flues it not properly carried out. The following recent case is an instructive one: In a certain factory the power requirements had increased somewhat, and on account of bad coal and poor firemen the steam production sank lower and lower, and the coal consumption rose higher and higher. On the advice of an outsider a sixth boiler was added to the five overworked ones. The trouble grew worse; even more coal was burnt, and less steam was produced. Several people were asked to give advice. On examining the various dimensions it was found that the flue area was only suitable for three boilers, and, as alterations could easily be made, the building of a larger flue was recommended. It was also discovered that there was a solid layer of flue dust, which must have been damp occasionally, of two feet in thickness. The factory can now be worked with the greatest ease with five boilers and the saving of coal is probably well over £1,000 per annum. This is stationary practice, but the facts are very significant, for locomotive enginemen.

Electrical Department

The Rotary Converter—Design and Construction—Methods Used In Starting—Application of Electric Motors to Machine Tool Drive

The Rotary Converter.

In the preceding article we considered the railway substation and described in detail the two principal methods used in getting high tension electric transmission wires into the building. We pointed out that the apparatus in the substation must be protected and that choke coils and lightning arresters are installed to prevent the lightning from entering the substation on the wires and damaging the electrical apparatus. Before considering those protective appliances we described the oil circuit-breaker, which connects and disconnects the high voltage current from the main apparatus, showing in detail its construction.

The railway substation as it is generally known is for the building containing machinery for converting high voltage alternating current into direct current, the direct current being connected to the overhead trolley wires or to the third rail, as the case may be, for the operation of electric cars or electric locomotives. The use of high voltage is economical, in that it is possible to generate all of the power for a long railway electric section at one centralized point in a main powerhouse. Electric power can then be distributed to the various substations located along the right-of-way at a high voltage and then stepped down to a lower voltage and converted into direct current for use by the electric motors. The generation of power at one point costs much less per unit of power (the kilowatt hour) than if generated at several points, and the losses in transmission are not excessive, the efficiency of a system of this kind being at least 80 per cent.

In the substation, as mentioned above, we have traced the current up to and through the oil circuit-breaker. Without considering, at the present time, the apparatus for lighting protection, the current after leaving the oil-breaker passes to the main apparatus.

This main apparatus consists of a bank of transformers (by a bank we mean a group or several, which usually consists of three), and the machine for converting the alternating current to direct current. The machine is a rotating one and is called a rotary converter or synchronous converter. The use of the first name is perfectly obvious, namely, that it is a piece of apparatus which converts electric current from one kind to the other and rotates. The use of the second name is equally obvious to the electrical man, but not quite so common, perhaps. The word synchronous means, to happen or take place at the same time—in other words, to keep in step. When applied to the electrical field it means that the machine is keeping step with the electric generator at the powerhouse. We know that alternating current is not of a constant value, but has a certain frequency or alternations. This frequency in the current waves, when connected to a closed field winding around the frame of a motor, causes rotation of the armature. There

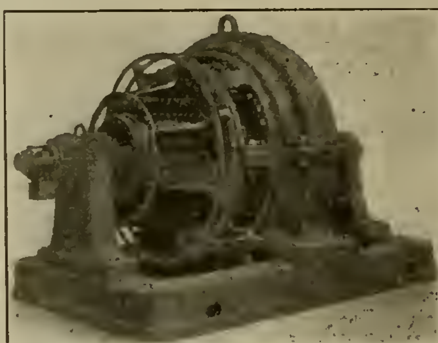


FIG. 1.—ROTARY CONVERTER COMPLETE.

are two kinds of alternating current motors, the induction motor and the synchronous motor. When a load is put on the induction motor the rotor or armature does not run as fast as the field rotates (the field rotation remains constant and only varies if the frequency varies), and the difference in speed is called the "slip." (See issue of March, 1911, page 125.)

The synchronous motor is different to

FIG. 2.—PARTLY ASSEMBLED.

FIG. 3.—COMPLETE ARMATURE.

this. The armature rotates in step with the field and does not vary with the load; in other words, there is no slip. The rotary converter is a synchronous motor driving a direct current generator, so to speak, except instead of two different machines coupled together the two features are combined into one machine. The speed is constant under all loads, hence the name synchronous converter.

Let us see how the conversion of alternating current into direct current takes place. The rotary converter consists of an armature revolving in a frame fitted with pole pieces and fields. A complete rotary converter is shown in Fig. 1.

The armature is of the drum-wound type. Thin sheet steel laminations are supported in dove-tailed grooves on a cast-steel spider, to which is fitted a commutator on one side and a series of copper rings on the other. The armature partially wound is shown in Fig. 2 and the commutator is shown in place. The completed armature looking at the opposite side and showing the slip rings is illustrated in Fig. 3.

The laminations are carefully annealed. They are assembled with air ducts for ventilation. The armature coils are form-wound and are interchangeable. One end of each coil is connected to the commutator as in the case of the direct current generator, but unlike the generator connections are made at the other end at certain positions, to the copper or collector rings.

The alternating current, passing through the circuit-breaker, is reduced or stepped down to a low voltage of approximately 400 volts by the bank of transformers. The low alternating current voltage is applied through the collector rings to the armature winding. The rotary then starts running, comes up to speed, and is in reality a synchronous motor. At the same time, on account of the rotation of the armature, the windings or the conductors are cutting the lines of force from the fields which are located around the frame, and this voltage is commutated by the commutator and direct current is taken off by means of the carbon brushes. As explained before, there is but one winding on the armature and it is connected to both the commutator and the collector rings. Analysis of the flow of currents in the armature winding shows that part of the current passes from the collector rings directly through the winding to the commutator and flows through but a part of the winding.

A rotary converter has a certain approximate ratio between the alternating current voltage applied and the double current voltage delivered, the ratio depending on the winding of the rotary. It is well to know these voltages and they are here tabulated for our readers. There are several different arrangements of winding rotary converters so that the ratio of the two voltages is given for each rotary machine concerned:

Type	Assuming D. C. Voltage to be 1.0 A. C. Voltage will be
Single phase	.707
Two phase	.707
Three phase	.615
Six phase double delta	.615
Six phase diametrical	.707

There are three different methods used in starting rotary converters, namely—(1) motor starting, (2) direct current self-starting, and (3) alternating current self-starting.

In the first method the shaft of the converter is extended and an induction motor is mounted on it of sufficient size to turn over the armature and bring it up to speed. The speed of the induction motor is higher than the synchronous speed of the rotary. In starting, the induction motor is run up, and when the speed of the rotary reaches that of the synchronous, the A. C. power is connected to the slip rings by the closing of the oil circuit-breaker. The current is then disconnected from the starting motor.

In the second method the rotary is started like a direct current shunt-motor by the application of the direct current. When speed is reached the A. C. is connected to the power supply and voltages adjusted so that the rotary is delivering D. C. current back into the D. C. line.

In the third case the converter is started by the direct application of the alternating currents, at reduced voltage, to the slip rings.

Applications of Motors to Machines

While the number of steam railroads which have been electrified is comparatively small, it does not signify that they are entirely unacquainted with the principles of electricity. Railroads are equipped with signals, small power stations are operated for light and power, and shops are provided with machine tools fitted with electric motors, giving individual drive. There are very few railroad shops which are entirely equipped with electric motor drive, and it is the purpose of this article to take up a few of the most common machine tools found in railroad shops and explain the correct methods of drive, together with the horsepower required for different sizes.

The horsepower recommended is based on average practice; it may be decreased for light work and must be increased for very heavy work. There are three classes of motors generally used in machine tool work namely: (1) Adjustable-speed shunt-wound direct current motors whereever a number of speeds is essential; (2) constant-speed shunt-wound motors (direct current) where the speeds are obtainable by a gear box or cone pulley arrangement or where only one speed is required; (3) squirrel-cage induction motor where direct current is not available. A gear box or cone pulley arrangement is used for different speeds.

Boring and Turning Mills. All three of the types mentioned may be used.

Size of tool	Horsepower Average	Heavy
37 to 42 inches	5 to 7½	7½ to 10
50 inches	7½	7½ to 10
60 to 84 inches	7½ to 10	10 to 15

Bulldozers or Forming or Bending Machines. Compound-wound motors are used for shunt wound.

Width Inches	Head Movement Inches	H. P.
29	14	5
34	16	7½
39	16	10
45	18	15
63	20	20

Drilling and Boring Machines. All three types may be used.

	H. P.
Sensitive drills up to ½ in.	¼ to ¾
Upright drills 12 to 20 in.	1
Upright drills 24 to 28 in.	2
Upright drills 30 to 32 in.	3
Upright drills 36 to 40 in.	5
Upright drills 50 to 60 in.	5 to 7½

	H. P. Heavy
Radial drills, 3 ft. arm	3
Radial drills, 4 ft. arm	5 to 7½
Radial drills, 5, 6, 7 ft. arm	5 to 7½
Radial drills, 8, 9, 10 ft. arm	7½ to 10

	H. P. Average
Radial drills, 3 ft. arm	1 to 2
Radial drills, 4 ft. arm	2 to 3
Radial drills, 5, 6, 7 ft. arm	3 to 5
Radial drills, 8, 9, 10 ft. arm	5 to 7½

Cylinder Boring Machines. All three types may be used.

Dia. of Spindle Inches.	Max. Boring Dia Inches	H. P.
4	20	7½
6	30	10
8	40	15

Lathes. All three types may be used.

Engine Lathes

Swing Inches	Horsepower Average	Heavy
12	¼	2
14	¾ to 1	2 to 3
16	1 to 2	2 to 3
18	2 to 3	3 to 5
20 to 22	3	7½ to 10
24 to 27	5	7½ to 10
30	5 to 7½	7½ to 10
32 to 36	7½ to 10	10 to 15
38 to 42	10 to 15	15 to 20
48 to 54	15 to 20	20 to 25
60 to 84	20 to 25	25 to 30

Wheel Lathes

Size Inches	H. P.	Tail Stock Motor H. P.
48	15 to 20	5
51 to 60	15 to 20	5
79 to 84	25 to 30	5
90	30 to 40	5 to 7½
100	40 to 50	5 to 7½

Many times it is very convenient to know the horsepower required to take a given cut on a lathe or other machines using a round-nose tool. Different horsepower is required for different metals. If we have a constant for each metal and know the cubic inches of metal removed per minute, then we can determine the horsepower. The rate of removing metal can be determined by the aid of a dia-

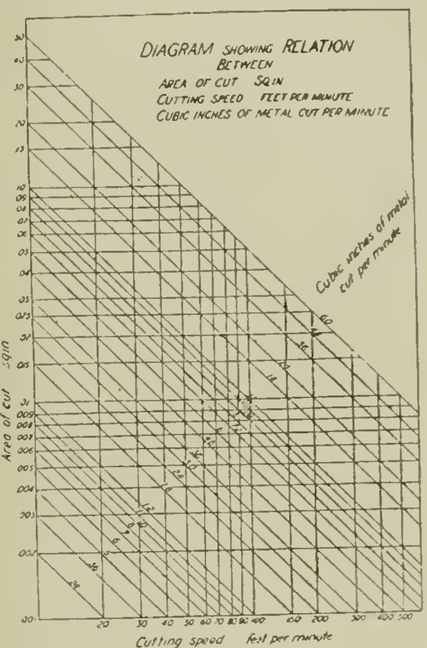


DIAGRAM OF RELATIONS.

gram. (Not shown.) The figures in the vertical column at the left represent areas of cut and those in the bottom horizontal row are cutting speeds in feet per minute. The figures on the oblique lines are cubic inches of metal removed per minute. To illustrate the use of such a diagram we will take an example. Assume that the cutting speed is 60 ft. per minute, that the depth of cut is ¼-inch and with 1/16-inch feed. The area of metal or cut is then .015 square inch. The intersection of the horizontal line through .015 and the vertical line through 60 is on the oblique line 11—i. e., there are 11 cubic inches of metal removed per minute.

Knowing the amount of metal removed, the constant for the metal being worked can now be applied. For cast iron from 0.3 to 0.5 H. P. per cubic inch per minute is required; for wrought iron, machinery steel, 0.6 H. P. per cubic inch per minute; for steel 50 carbon and harder, 1.00-1.25 H. P. per cubic inch per minute; for brass and similar alloys, 0.2 to 0.25 H. P. per cubic inch per minute.

For the average work of drills the H. P. is estimated in a similar way. The cubic inches per minute are calculated by the formula $Q \div .7854 \times d,f$, where d is the diameter of the drill in inches and f the feed in inches per minute. The constants to apply are approximately double those given above.

Headway or Spacing of Trains

By WALTER V. TURNER, Manager of Engineering, Westinghouse Air Brake Co.

Obviously the design of an efficient brake for passenger equipment is very closely related to the headway or spacing of trains on which the brake is to be used, and the fundamental consideration for the headway or spacing of trains is the element of safety. Safety of operation in turn depends upon the possible retardation or ability to stop; the maximum speed, and the installation and characteristics of signal apparatus. These factors are arranged in order of relative importance, though, of course, each is closely bound up in, and not to be disassociated from, the others.

The minimum headway for the movement of trains may be determined in two different ways. One method is to base the proper time interval between the trains, on a system of trains *running at maximum speed.* The other is to base this time spacing on the *closing-up of trains at stations.* The method of these two which gives the larger minimum headway must be the one to use for the conditions in question, for obviously of two critical values, the safer—which is the larger—must always be chosen.

In the subsequent analysis certain assumptions are to be understood, namely, straight and level track, with no irregular local conditions, and carrying traffic in one direction only; a block system equal in length to *twice* the emergency stop distance from the maximum speed; stop distances proportional to the square of the maximum speed, duration of retardation directly proportional to the maximum speed.

It is needless to attempt an investigation of this kind with a thousand and one variables. The modifications necessary to apply the results herein established to special conditions of grade, curvature, interlockings, and other local conditions will be apparent, once the results are understood. The above assumptions are sufficiently accurate in every respect to make worth while this analysis of the factors influencing headway for train movements. No attempt will be made to deal with the laying out of a signal system for the system of trains to be considered, as this may be found complete and in detail elsewhere.

In general, trains running at speed should be spaced by a distance equal to the sum of—

1. The length of the train.
2. The length of the complete block system.
3. The distance between the distant and home signal.
4. The distance sufficient to permit the signal to clear and the engineman to identify the signal indication.

In the New York Subway the overlap system of signals is used, which provides for two home signals and one distant signal protecting the rear of each train. In order to give each following train a clear distant signal (and this should be the normal condition), the complete block section plus the distance between the distant signal and the second home signal should be taken as three times the length of the block, or as six times the emergency stop distance of the train.

The distance spacing for this system is illustrated in the following figure.

The Constant C (item 4 in the list above) may be a given distance or a given time. If taken as a constant distance, the time will, of course, vary, according to speed. The Time spacing or speed, that is, the braking distance will equal some constant times the square of the speed. Whence, substituting in (1)

$$(2) \qquad H_r = \frac{kV^2 + NL + C_s}{1.467\,V}$$

If the allowance C, as illustrated, be taken as Time instead of a space constant to permit signals to clear and motorman to identify them, (2) becomes,

$$(3) \qquad H_r = \frac{kV^2 + NL}{1.467\,V} + C_t$$

Solving (3) for V, we have in quadratic form

$$(4) \quad V = .733\frac{(H_r - C_t)}{k} + \frac{\sqrt{215(H_r - C_t)^2 - 4kNL}}{2k}$$

The headway determined by closing up

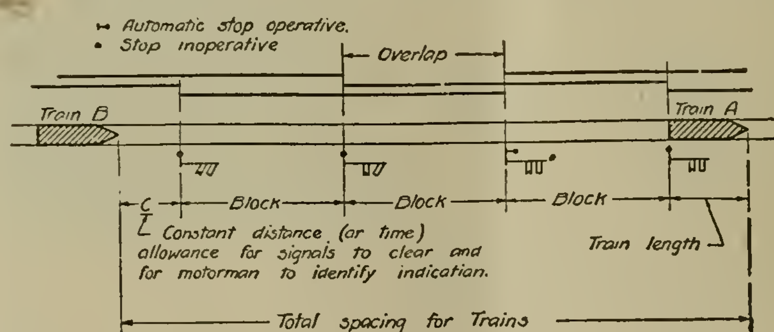


DIAGRAM OF OVERLAP SYSTEM OF BLOCK SIGNALS ILLUSTRATING SPACING OF TRAINS.

headway between trains will be the time necessary to run this total distance spacing, or expressed mathematically,

$$(1) \qquad H_r = \frac{6S_e + NL + C_s}{1.467\,V}$$

where:

H_r = headway determined by running at speed (seconds);

S_e = emergency stop distance (feet) from

V = maximum speed (mph);

C_s = *space* constant (feet);

N = number of cars in train;

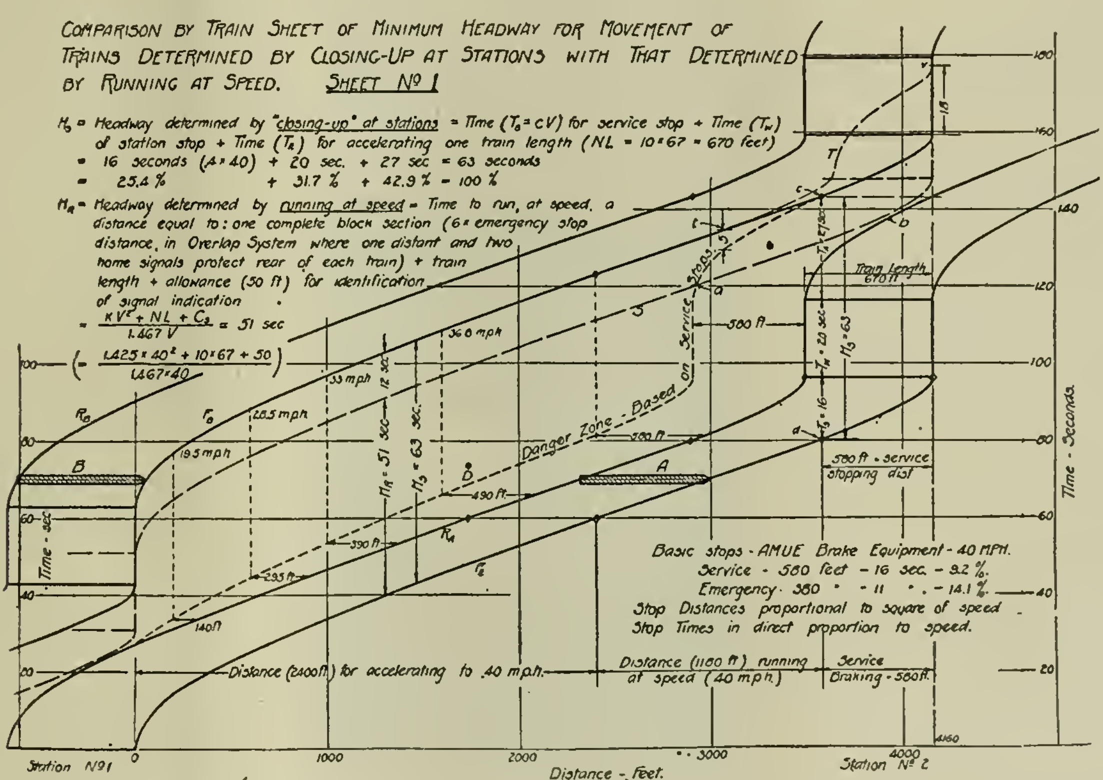
L = length of each car (feet).

While the kinetic energy of a train varies directly with the square of the speed, the retarding force, due to the brake shoe friction, is decreased with an increase of speed. On the other hand, the initial or reflex time required for getting the brakes into action—constant of course for any speed—is of decreasing importance, relative to the total time for stopping, as the speed is increased. It is found that the influence of these two factors, reflex time and brake shoe friction, are approximately counteractive, and, therefore, the stop distance will vary directly with the square of the speed ... at stations is illustrated in the attached diagram indicated as sheet No. 1, and a comparison is made with the headway determined by running at speed. The progress of two trains, B following A from one station to another, is traced by the lines F and R. These lines mark the progress of the front and rear ends of each train on a time-distance basis. Train B is shown just having left the first station at the time (70 seconds) after train A has advanced from this station about 3,000 feet and is running at full speed. Train A stops at the second station, 4,160 feet from the first, at about 96 seconds after leaving the first. After a station stop of 20 seconds, as shown, it starts again for the third station (not shown).

Curve D (dotted) marks the danger zone inside which the head end of train B must not come if the rear end of the train A is to be safe. This zone is based upon the service braking distance for the speeds at which train B is running under normal operation at the particular points in question along the right of way. Curve Fb is tangent to curve D at point c, where the braking must begin for the stop of train B at station two. The time

interval between this critical point for train B and the corresponding point d for train A is the headway (Hs), determined by trains closing up at stations and is seen to be the sum of, (1) the time to make the service stop, (Ts); (2) the time the train is held at the station (Tw), and (3) the time required to accellerate one train length (Ta). This is the limiting or critical value for the headway and cannot, of course, be realized in actual practice, because, among other things, the time of station stop will change with varying numbers of passengers to be loaded or handled. Suppose, under the condition shown, the time of station stop for train A had been lengthened 5 seconds. This would cause an intersection of curve D with Fb at t, requiring that train B start braking at (27 seconds) to accelerate one train length (670) feet), the time for service braking is only 25 per cent, the time of station stop, 32 per cent, and the time to accelerate, 43 per cent, of the total headway of 63 seconds. The recent improvement made in the electro-pneumatic brake in reducing by two seconds the reflex time for brake application still further diminishes the comparative slight interference which the modern brake offers to the proposition of operating trains without any headway at all. In other words, the air brake art, as exemplified in rapid transit service, has come to that stage of perfection, has so far maintained its lead in the advance of other factors entering into the movements of trains, that a 10 per cent improvement in the brake performance would now result stop now requiring but 14 seconds and 500 feet, the significance may be better grasped of the above comparison as to realization of opportunity and fulfillment of economic trust in the development progress of the air brake.

Curve S of the diagram under consideration, represents the time-distance path of the front end of train B following A on a headway (Hr) of 51 seconds, determined by running at the maximum speed of 40 miles per hour. This is 12 seconds less than the headway (Hs) determined by closing up at stations, therefore the latter must govern; for note that curve S enters the danger zone at a, and if train B were permitted to continue as indicated by S, it would come within 40 feet of train A at b. Were anything to detain train A by one sec-



this point and advance to the usual station stop at point v, as indicated by curve T. In this case the initial delay of 5 seconds has resulted in a final delay of 18 seconds. This would react correspondingly on the trains following B, causing an ever-accumulating delay until the whole service would be disorganized. The actual headway for service must allow a comfortable safety factor to avoid troubles of this kind. However, for the purposes of comparison, the theoretical minimum for headway will be used in every case unless otherwise noted.

Examination of the three factors that go to make up the headway based on closing up at stations reveals that, with the assumed condition of speed (40 miles per hour), service braking distance (580 feet) and time (16 seconds), and time in only 2.5 per cent betterment in the total headway, whereas a 10 per cent improvement in the acceleration would mean a 4.3 per cent reduction in headway, or almost twice the saving. Do not make the mistake of believing that the part of the brake here resembles a saving of 10 per cent in the cost of brass buttons for the conductor, which results in a net overall saving in operating expenses of one ten-thousandth of one per cent or less. It should not be necessary to emphasize the fact that the ability to move trains at all depends upon the ability to control them. When it is considered that the brake equipment in the same subway service in 1906 required 41 seconds and 1,450 feet, with no measure of the same application flexibility and no release flexibility whatever, to make the ond or more, either at the station or after starting therefrom, a collision would be the result. Were braking to commence on train B at point a, due to proper signal observance of the danger zone, the initial delay of 12 seconds would be multiplied into a longer delay.

Preventing Rust.

A new rust preventing process for machines is an application to the surface of the iron or steel of iron phosphates, which are insoluble, and not corroded under ordinary conditions. After thorough cleansing, a bath containing ferric and ferrous phosphates is prepared and the articles immersed in the bath, and then a little managanese dioxide is added, at boiling water temperature.

Items of Personal Interest

Mr. John R. Tunison has been appointed traveling fireman of the Central Railroad of New Jersey.

Mr. Harry J. Freund has been appointed traveling fireman of the Central Railroad of New Jersey.

Mr. C. E. Nutter has been appointed chief electrician of the Santa Fe at Topeka, Kan., succeeding Mr. L. M. Gazin.

Mr. R. C. Beaver has been appointed assistant mechanical engineer of the Bessemer & Lake Erie, with office at Greenville, Pa.

Mr. F. N. Wilson, formerly engineer of fuel economy of the Chicago, Rock Island & Pacific, has been appointed chief fuel inspector.

Mr. B. J. Peasley has been appointed mechanical superintendent of the St. Louis Southwestern of Texas, with office at Tyler, Tex.

Mr. L. F. Couch has been appointed master mechanic of the Memphis, Dallas & Gulf, with office at Nashville, succeeding Mr. F. J. Sears.

Mr. J. B. Conerly has been appointed master car builder of the Missouri, Kansas & Texas Lines, with headquarters at Denison, Texas.

Mr. A. H. Hackfield has been appointed master mechanic and roadmaster of the Southwestern railway, with office at Anchor City, Tex.

Mr. Howard H. Kane has been appointed master mechanic of the Gulf Coast Lines, Texas Division, with office at Kingsville, Tex.

Mr. R. D. Wilson has been appointed assistant chief car inspector of the Central Railroad of New Jersey, with office at Jersey City, N. J.

Mr. E. S. Pearce has been appointed mechanical engineer of the Big Four at Beech Grove, Ind., succeeding Mr. W. E. Ricketson, promoted.

Mr. P. S. Winter has been appointed general car foreman of the Bessemer & Lake Erie, with supervision over the car shops at Greenville, Pa.

Mr. Ernest S. Draper has been appointed engineer of structures of the Boston & Albany, with office at Boston, Mass., succeeding Mr. A. D. Case.

Mr. R. H. Nicholas, formerly general foreman of the Central of New Jersey at Communipaw, N. J., engine terminal, has been appointed assistant master mechanic.

Mr. W. J. Eddy, formerly superintendent of fuel economy of the Chicago, Rock Island & Pacific, has been appointed master mechanic, with office at El Dorado, Ark.

Mr. Charles T. Sugars has been appointed master mechanic of the Louisiana & Northwest, with headquarters at Homer, La., succeeding Mr. J. S. Motherwell, resigned to accept service with another company.

Mr. Albert Husk has been appointed foreman of the Nashville, Chattanooga & St. Louis shops, at Lexington, succeeding Mr. S. L. Hernden, assigned to other duties.

Mr. Daniel Sinclair, formerly road foreman of engines of the Northern Pacific, with office at Glendive, Mont., has been appointed fuel supervisor, with office at Glendive.

Mr. J. H. Weston has been appointed road foreman of engines on the Minnesota division of the Northern Pacific, with office at Staples, succeeding Mr. M. S. Montgomery.

Mr. A. E. Warren, formerly assistant manager of the Canadian Northern has been appointed head of Canada's government owned railway systems, with headquarters at Ottawa.

Mr. D. R. Davis has been appointed roundhouse foreman of the Chicago, Milwaukee & St. Paul at Ottumwa Junction, Ia., succeeding Mr. H. Collins, transferred to Savanna, Ill.

MAJOR FREDERICK MEARS.

Mr. S. W. Law, formerly electrical signal engineer of the Northern Pacific, with office at St. Paul, Minn., has been promoted to assistant signal engineer, with office at St. Paul, Minn.

Mr. Thomas Allison has been appointed road foreman of engines on the Pasco division of the Northern Pacific, with headquarters at Pasco, Wash., succeeding Mr. C. A. Wirth, promoted.

Mr. J. S. Motherwell, formerly master mechanic of the Louisiana & Northwest at Horner, La., has been appointed master mechanic of the Oklahoma, New Mexico & Pacific, with office at Ardmore, Okla.

Mr. F. Meredith, formerly road foreman of equipment of the Chicago, Rock Island & Pacific at Silvis, Ill., has been appointed supervisor of fuel economy of the Iowa, Nebraska & Colorado divisions, with office at Fairbury, Neb.

Mr. W. W. Warner, formerly foreman of the car department of the Erie at Cleveland, Ohio, has been appointed shop superintendent at Kent, Ohio, with jurisdiction over the west half of the Meadville and east half of the Kent divisions.

Mr. A. J. Klumb, formerly assistant master mechanic of the Milwaukee shops of the Chicago, Milwaukee & St. Paul. has been appointed division master mechanic on the Prairie du Chien and Mineral Point division, with office at Milwaukee.

Mr. P. Smith, formerly assistant engineer of fuel economy of the Chicago, Rock Island & Pacific, has been appointed supervisor of fuel economy on the Cedar Rapids, Minnesota, Dakota & Des Moines divisions, with office at Cedar Rapids, Ia.

Mr. S. H. Brenamen, formerly resident engineer on the improvement work done by the Pennsylvania in Johnstown, Pa., and vicinity, has been placed in charge of the survey for the electrification of the Pennsylvania between Johnstown and Altoona.

Mr. J. E. Buckingham, formerly northwestern representative of the Standard Steel Works Company, with offices in the Northwest Bank Building, Portland, Ore., has been appointed general manager of the Hofins Steel & Equipment Company, Seattle, Wash.

Major Frank G. Jonah, formerly chief engineer of the St. Louis-San Francisco, has been appointed chief engineer in charge of light railways in the office of the director-general of transportation in France. Major Jonah was attached to the 12th Engineers.

Mr. H. D. Webster has been appointed engineer of motive power of the Bessemer & Lake Erie; Mr. C. C. Richardson, assistant to the superintendent of motive power; Mr. F. W. Dickenson, master car builder, and Mr. C. L. Tuttle, mechanical engineer; all with headquarters at Greenville, Pa.

Mr. E. T. Mumma, formerly electrical engineer in charge of the electric substations of the Chicago, Milwaukee & St. Paul main line, has been appointed superintendent of the telegraph and telephone department on the Anchorage division of the Alaska railways, succeeding Mr. Herbert Gaytes.

Mr. A. R. Ruiter, formerly master mechanic of the Rock Island at Kansas City, Kan., has been transferred to El Reno, Okla., as master mechanic, succeeding Mr. G. M. Stone, transferred to Manly, Ia., as master mechanic, suc-

ceeding Mr. N. T. Fitzgerald, transferred to Trenton, Mo.

Mr. J. K. Booth, formerly general foreman of the Bessemer & Lake Erie, at Greenville, Pa., has been appointed master mechanic, with supervision over the locomotive department shops at Greenville, and Mr. E. F. Richardson has been appointed assistant to the engineer of motive power.

Mr. F. S. Wilcoxen, formerly mechanical representative of the Pilliod Company, New York, has accepted a position with the Perolin Railway Service Company as special representative. Mr. Wilcoxen has had a thorough experience as an all-round railway man in the mechanical departments of several of the leading railways.

Mr. H. C. Dimmitt, formerly district master mechanic of the River and Iowa & Minnesota divisions of the Chicago, Milwaukee & St. Paul, has been appointed division master mechanic of the same division, and Mr. P. J. Muller, formerly roundhouse foreman at Sioux City, Iowa, has been appointed master mechanic of the Southern Minneapolis division, with office at Austin, Minn.

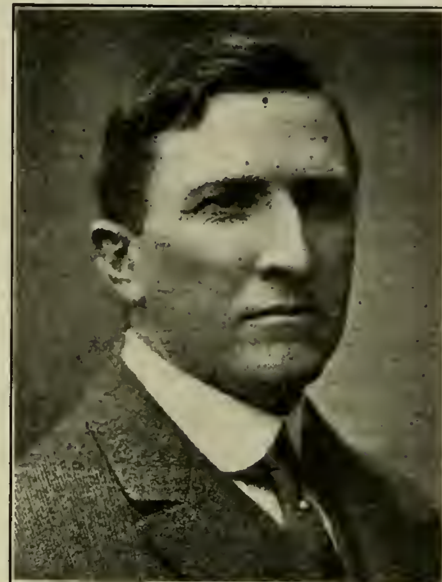
Major Frederick Mears, formerly member of the Alaskan Engineering Commission operating the government railroad in Alaska, has resigned his place in the commission to join the railroad engineering forces in France, and Mr. William Grey, consulting engineer on the Alaskan Engineering Commission has been appointed engineer in charge of the Anchorage division of the Alaska railways.

Mr. J. W. White has been appointed manager of the power and railway division of the Detroit office of the Westinghouse Electric & Manufacturing Company. Mr. White was formerly connected with the Pittsburgh office of the company, subsequently becoming associated with the Allis Chalmers Company, and has now returned to the Westinghouse Company, assuming the position above noted.

Mr. W. H. Hart, formerly assistant district master mechanic of the Superior division of the Chicago, Milwaukee & St. Paul, with office at Green Bay, Wis., has been appointed division master mechanic with the same headquarters, and Mr. J. Bjorkholm, formerly traveling engineer, with office at Milwaukee, Wis., has been appointed master mechanic of the Chicago terminal with office at Chicago, Ill.

Mr. J. H. Phillips, formerly traveling engineer of the Chicago, Milwaukee & St. Paul, has been appointed division master mechanic on the Northern division, with office at Horicon, Wis., and Mr. John Turney, formerly assistant master mechanic of the Twin City terminals, with office at Minneapolis, Minn., has been appointed division master mechanic of the same division, with office at Minneapolis.

Mr. M. F. Smith, formerly division master mechanic on the La Crosse and Wisconsin Valley division of the Chicago, Malwaukee & St. Paul, with office at Milwaukee shops, has been promoted to district master mechanic with the same headquarters, and Mr. William Joost, formerly roundhouse foreman at the Milwaukee shops, has been appointed master mechanic of the Milwaukee terminal and the Chicago and Milwaukee division, with office at Milwaukee.



W. J. JENKS.

Mr. Milton Rupert has been elected vice president and assistant treasurer of the R. D. Nuttall Company, Pittsburgh, Pa., manufacturers of gear, pinions and trolleys. Mr. Nuttall has been employed for the last twenty-seven years in various capacities in the company's service and is familiar with all office and manufacturing operations. Latterly he was assistant to the president and general manager. He will have charge of sales and manufacturing activities.

HENRY H. VAUGHAN.

Mr. N. L. Bean, formerly assistant to the president of the New York, New Haven & Hartford, has been appointed assistant to the general mechanical superintendent. Mr. Bean graduated from the University of Minnesota as mechanical engineer in 1902, and served as special apprentice with the Great Northern. He served in various official capacities in the mechanical department of several of the Western roads, and also as locomotive inspector at the Baldwin Locomotive Works.

Mr. W. J. Jenks, formerly general superintendent of the Western general division of the Norfolk & Western, has been appointed general manager of the road. Mr. Jenks has had a wide experience in the operating department of the leading railroads in the South. He is from Raleigh, N. C., and entered railroad service in 1886 as telegraph operator on the Raleigh & Augusta Air Line, now the Seaboard Air Line, and has served as chief dispatcher, trainmaster, superintendent and chairman of the car allotment committee.

Mr. Thomas J. Cole, formerly master mechanic of the Erie at Meadville, Pa., has been appointed shop superintendent at Meadville. Mr. T. F. Gorman, general foreman at Brier Hill, Youngstown, Ohio, has been appointed master mechanic of the Meadville division, succeeding Mr. Cole. Mr. Lee R. Laizure, formerly master mechanic at Hornell, N. Y., has been appointed shop superintendent at Hornell, and Mr. Albert J. Davis, formerly general foreman at Hornell, has been appointed master mechanic of the Allegheny and Bradford division, with office at Hornell.

Mr. Henry H. Vaughan has been elected president of the Canadian Society of Civil Engineers. Mr. Vaughan was born in England in 1868 and came to America in 1891. He had some experience in railway shop work in England, and after several years' service with the Great Northern, he became mechanical engineer of the Q. and C. Company, and of the Railway Supply Company of Chicago. In 1902 he became superintendent of motive power of the Lake Shore & Michigan Southern, resigning in 1904 to accept a position with the Canadian Pacific as superintendent of motive power for eastern lines. In 1905 Mr. Vaughan was appointed assistant to the vice-president, and resigned in 1915 to accept the presidency of the Montreal Ammunition Company. Mr. Vaughan is also vice-president and manager of the Dominion Copper Products Company, vice-president of the Albany Car Wheel Company, and is a member of the board of directors of the Dominion Bridge Company. Mr. Vaughan was president of the American Railway Master Mechanics' Association in 1908, and is a member of many of the leading engineering societies.

OBITUARY.

George W. Kiehm.

It is with a feeling of profound sorrow that we have learned of the death of George W. Kiehm, at his residence in Washington, D. C. Mr. Kiehm was in the front rank of air brake experts in America and conducted the Air Brake Department in RAILWAY AND LOCOMOTIVE ENGINEERING since 1909. He was also chief air brake inspector of the Washington Terminal Company. He was from Johnsbury, Pa., and entered the service of the Baltimore & Ohio in 1895. He had a wide experience on several of the Eastern roads, particularly on the Annapolis, Washington & Baltimore, the Pennsylvania, and latterly on the Washington Terminal. Of a studious disposition, his writings, particularly on air brake subjects, were marked by clearness and a degree of exactness that has had few equals. Many of the leading air

GEORGE W. KIEHM.

brake instructors have been using Mr. Kiehm's monthly contributions to our pages as the leading feature of their instruction to railway men studying the air brake. The course now running in the Question and Answer form is among his leading works, and as he had finished the complete series, his work will continue to appear in our pages for the greater part of the present year. Of a modest and gentlemanly disposition, he was much esteemed in railroad circles and will be greatly missed at the conventions and other meetings of railway men.

Air Brake Association

The executive committee of the Air Brake Association at a recent meeting has decided to hold the 1918 annual convention The date fixed is May 7-10, at Cleveland, Ohio. Existing war conditions are believed to be a compelling force to hold a convention, rather than a deterrent against it, for the good reason that the Air Brake Association is an educational organization whose whole activities are directed to improve the air brake service on American railroads, and doubly so in war times. In referring to the shortage of material, Mr. C. H. Weaver, president of the association, calls the attention of the members to the fact that there are many parts of the air brake apparatus which can be repaired by bushing worn portions, such as air pump cylinders, main valve bushings and caps, governor steam body, feed valves, triple valves, control valves, distributing valves and brake valves. Air valve cages and caps can be made of steel. Air pump piston rods can be forged from old axles, and many packing leathers and leather gaskets of all kinds may be reclaimed by the refilling process at a small cost. Other parts too numerous to mention here may be reclaimed. Don't forget the importance of the scrap pile in reclaiming and conserving material. All material saved and repairs made not only save money and delay to the railroads, but leave the manufacturer free to furnish more of such material that cannot be repaired.

Mr. D. L. McBain, superintendent of motive power, New York Central Lines, will address the convention at its opening, May 7, and Mr. Walter V. Turner will deliver a lecture on a timely subject May 8.

Central Railway Club

The twenty-eight annual dinner of the Central Railway Club was held in Buffalo, N. Y., last January. An interesting paper on "What constitutes the equipment department and the advantages offered in this department for the advancement of young men," by Mr. F. W. Brazier, superintendent of rolling stock, New York Central Lines. At the banquet in the Hotel Statler, Mr. Charles C. Castle, vice-president of the Railway Appliance Company, acted as toastmaster.

Short Line Railroad Association.

The American Short Line Railroad Association has amended its constitution so as to admit not only members from the Southern roads, but from all parts of the United States. Its main office is located at 709 Union Trust Building, Washington, D. C. The officers are: President, Bird M. Robinson; vice-president, B. S. Barker; secretary, T. F. Whittelsey; assistant secretary, M. M. Ashbaugh; general counsel, S. S. Ashbaugh.

A large number of new members have been added to the roll.

Shop Stewards

A new functionary has recently made his appearance in Great Britain. He is supposed to be useful regarding the settlement of shop grievances, and for all practical purposes the question of the recognition of the Shop Stewards has been settled in favor of this new element in trade organization. The new agreement is described as an instrument for avoiding disputes, and it is proposed that the workmen of the unions employed in federated establishments shall be entitled to appoint representatives from their own members to act for them. The method of election of the shop stewards is determined by the unions. Although they are to be subject to the control of the unions to which they belong, it is a long step in democratic shop government. There ought to be less room for misunderstandings, and difficulties should be dealt with promptly. In that prospect of the quick handling of disputes lies the important hope.

The functions of the shop stewards are shown by the suggested functions and shop stewards' method of procedure in case of disputes. (1) A workman or workmen desiring to raise any question in which he or they are concerned shall discuss the matter with his or their foreman. (2) Failing settlement, the question shall, if desired, be taken up with the management by the appropriate shop steward and one of the workmen concerned. (3) If no settlement is arrived at the question may, at the request of either party, be further considered at a meeting of the management and the appropriate shop steward, together with a deputation of the workmen concerned. At this meeting the organizing district delegate may be present, in which event a representative of the Employers' Association shall also be present. (4) The question may thereafter be referred for further consideration in terms of the provisions for avoiding disputes. (5) No stoppage of work shall take place until the question has been fully dealt with in accordance with this agreement and with the provisions for avoiding disputes.

Wiped Joint.

In these days when many find it necessary to make small repairs it is frequently convenient to be able to make a wiped joint. To do so, melt the solder in a ladle and pour it in the joint quite plentifully, As the solder accumulates wipe it into shape with a piece of canvas folded several times and greased with tallow. The canvas is also very useful to hold the solder as it is being poured upon the joint.

A little practice will make any handy man perfectly proficient at the job, and be ready for an emergency.

Practical Coal Saving

In glancing over the report recently issued by the Department of the Interior (Bureau of Mines) one very significent feature is likely to attract the notice of the thoughtful. It is this:

Constant effort to strengthen the interest and co-operation of engine and terminal men to assist, and to feel themselves partners in the work, is made largely through the use of such figures as are given by the Bureau.

Of prime importance is the use of figures for individual road engines, showing consumption of coal in pounds per 1,000 gross ton miles, both passenger and freight service. This data is prepared by an accounting force and the records of the various engines are examined and memoranda made concerning cases of engines whose consumption is running out of line with good practice; class of power and service considered. Fuel supervisors then ride on the engines and make reports to the master mechanics of defective boilers, machinery, draft rigging, grates, plugged flues, etc. Also, if needed, the crews are instructed in the proper handling methods; or the terminal may be checked with regard to coal used during lay-overs.

Here is the common sense idea not only in telling men what is required but why it is required, and showing them where, by complying with the order, the gain to the company and to themselves really lies. Giving an order, apparently without rhyme or reason is apt to be looked upon out on the road as a method of showing authority, and in any case it smacks too much of the Prussian drill sergeant's methods, to be of any real value on a railway in this country. Tell the men what you want and why you want it, that is the best way. Issuing an order and putting one's feet up on a mahogany desk and lighting a cigar never worked out in practice except in the form of dismal failure, as far as the order is concerned.

The supervision of fuel naturally includes losses by overloading of tenders; by waste about coaling stations; by failure to remove all coal from coal cars; by preventing theft; by loss through holes in decks of engines, and by all similar means. Fuel supervisors should report the need for cleaning up coal which is dropped along the right-of-way so that it can be utilized at section houses and for station needs, and for switch shanties, etc. The general fuel supervisor should bring to the notice of the higher operating officers any cases of misuse of power, resulting in fuel waste; as, for example, unnecessary double-heading, light mileage, excessively large engines on small trains, etc. Superintendents should endeavor to lessen the delay in transit of all trains, and particularly, heavy freight trains. Attention ought to be given to the fact that the stopping of freight trains entails a serious loss of fuel from which no returns are had, and care must be exercised by dispatchers to avoid, if possible, the stopping of trains at the foot of steep grades, from which points it is difficult and expensive to start.

As as example of good methods well applied the N. Y., N. H. & H. Railroad may be cited, on that road the saving of fuel has the constant attention of practically all employees in the operating department, beginning with the superintendents and ending with the men who clean the fires on the ashpit. Their attention is constantly directed to the savings produced by careful thought and action and to the losses resulting from inattention and neglect. In order to determine the net results on a broader scale than by such estimates as have gone before, some figures from actual operation of all engines in freight and passenger service, both yard and road, are appended to show that the varied efforts have produced a very considerable reduction in coal consumption, and consequent large monetary saving. Comparison is made between the performance in September, 1917, versus 1916; the results for which are typical of those for broader periods. The statistics of coal used are those covering all issues to locomotives as charged under the primary accounts, I. C. C. classification.

Proper loading of trains with respect to engine capacity is of the greatest importance in obtaining a low unit consumption. An overloaded engine is wasteful of fuel. An underloaded engine is equally so, measured in "gross ton miles per unit of coal used." An engine with two-thirds its rating will burn nearly as much coal per train mile as it will with full rating, and the ton-mile cost is correspondingly high.

The New York, New Haven & Hartford Railroad estimates a fuel saving amounting to more than a million and a third dollars, based on comparison of actual performance of its locomotives in December, 1917, as against December, 1916. It gives an indication of the ideal that can be approached by the railroads of the country and the tremendous saving that can be accomplished not only from a money point of view but also in the actual saving of coal.

There were 313,713,362 gross passenger ton miles handled in September, 1917, which, if 1916 consumption rate had prevailed this year per 1,000 gross ton miles, would have required 9,729.5 more tons of coal than were actually burned. Since the cost of coal on tenders averaged $5.09 per ton, the saving was $49,523 for the month, or at a yearly rate of $594,276.

There were 632,287,097 gross freight ton miles handled in September 1917, which, if 1916 consumption rate had prevailed this year per 1,000 G. T. M., would have required 8,757 more tons of coal than were actually burned. Since the cost of coal on tenders averaged $5.09 per ton, the saving was $44,573 for the month, or at the rate of $534,876 per year.

Under the stress of these war times, numerous changes in the personnel of firemen in railroad service, makes education much less complete than is desirable or possible in more stable times, but continued effort made to instill into the enginemen and firemen, the seriousness of the coal shortage and the tremendous burden which the present high prices place on their own road, and the entire nation, is a good productive work.

When the men are told of the current prices of coal charged to the company they usually express surprise, as, generally, they have not realized that the extraordinary prices of the present, affect the railroad to the same extent as they are affected in their personal living expenses. Almost without exception the men agree to cooperate in fuel saving. Tell the men what you want and why you want it. This plan has been tried in practice and it has been found to be of the very greatest value. It succeeds every time.

Animals Killed on Railroad Tracks.

President Herbert, of the St. Louis Southwestern, has presented in striking fashion, for his road, a placard, conspicuously posted, setting forth the fact that in 12 months 2,792 cattle, horses and sheep were killed on the Cotton Belt Route. and that the bodies of these animals, if they had been worked up in packing houses instead of being wasted on a railway right of way, would have produced more than 1,000,000 pounds of food products—"or the equivalent of the meat ration of 70,000 soldiers for approximately 30 days." The placard tersely emphasizes the fact that this is not only an enormous waste of food, but also a drain on the resources of the railway company at a time when every dollar of its income should be used productively.

Not only so, but the question naturally arises, if this loss is incurred on 1,809 miles in the cotton belt country, what does the loss amount to on 270,000 miles of track most of which passes through regions where the production of food animals is greater in comparison, and what for the whole country?

Making Coal Dust Non-Explosive.

There are two general methods of rendering coal dust non-explosive—first, by wetting the dust to prevent a cloud of dust from being formed, because only when the coal dust is in a cloud is it explosive; second, by adding to the coal dust enough incombustible dust to make the mixture non-explosive. The Bureau of Mines says the first method is extensively used; the second is comparatively new in the United States.

Railroad Equipment Notes

The Philadelphia & Reading will build 15 locomotives in its own shops.

The Chicago, Milwaukee & St. Paul is contemplating the purchase of 50 steam locomotives.

The Southern will build a work shop and engine repair shed, 30 by 80 ft., at Bull's Gap, Tenn.

The Louisville & Nashville has ordered 300 steel underframes from the Pressed Steel Car Company.

The Republic Iron & Steel Company has ordered 200 coke cars from the Pressed Steel Car Company.

The Lehigh Valley has let a contract for the building of a boiler house, 40 by 118 ft., at Perth Amboy, N. J.

The Chilean State Railways have ordered 20 Mikado locomotives from the American Locomotive Company.

The Nashville, Chattanooga & St. Louis is installing electric welding machines in its boiler shop at Nashville, Tenn.

The Green Bay & Western has placed an order with the American Locomotive Company for 2 Mogul locomotives.

The Colombian Northern has ordered 2 third-class passenger coaches from the American Car & Foundry Company.

The Columbian Northern has ordered six 15-ton wooden gondolas from the American Car & Foundry Company.

The Delaware, Lackawanna & Western has ordered 15 Mikado locomotives from the American Locomotive Company.

The United States Navy has ordered 60-ton steel underframe box cars from the American Car & Foundry Company.

The Wichita Falls & Northwestern will rebuild a mechanically-operated coal chute at Frederick, Okla., recently destroyed by fire.

The Pennsylvania Company's repair and machine shops at Pitcairn, Pa., were recently damaged by fire; estimated loss is $35,000.

The Richmond, Fredericksburg & Potomac, Richmond, Va., is having plans prepared for an addition to its engine house to cost $20,000.

The Norfolk & Western has placed orders with the American Locomotive Company and the Baldwin Locomotive Works for 40 engines, each builder to take half the contract.

The Vicksburg, Shreveport & Pacific has under construction at Monroe, La., an engine house and shop building and will build a coach and paint shop.

The Nashville, Chattanooga & St. Louis is building new roundhouse and repair shops at Chattanooga, Tenn.; also putting in a pumping station at that point.

The Louisville & Nashville has let contracts to the Roberts & Schaefer Company for coal-handling machinery for a coaling plant at Nashville, Tenn., and a 400-ton concrete coaling plant at Guthrie, Ky.

The Atchison, Topeka & Santa Fe is building additional repair shops at Ottawa, Kan., at a cost of about $60,000. Swanson Brothers Contracting Company, Topeka, Kan., has the contract for the work.

The Chilean State Railways recently ordered 20 Mikado locomotives from the American Locomotive Company. These locomotives will have 22 by 28-in. cylinders, a total weight in working order of 195,000 lb. and will be superheated.

The Hocking Valley has authorized the installation, complete, of a Robertson cinder equipment to be installed alongside of a 300-ton concrete coaling plant which the Roberts & Schaefer Company is building for this line at Nelsonville, Ohio.

The Bessemer & Lake Erie has placed an order with the Roberts & Schaefer Company for the equipment for a coaling plant of 400 tons' capacity, using four "R and S" measuring coal loaders, electrically operated, for North Bessemer, Pa.

The United Railways of Yucatan have ordered from the Railway Storage Battery Car Company, New York, three 55-ft. all-steel storage-battery passenger cars, and two 27-ft. baggage and express trailers for service between Progresso and Merida.

The Rhodesian Railways have ordered 9 mountain type locomotives from the American Locomotive Company. These locomotives will have 22 by 24-in. cylinders, a total weight in working order of 172,000 lb. and will be equipped with superheaters.

The Oregon-Washington Railroad & Navigation Company is building a roundhouse at Tacoma, Wash., which will cost about $10,000. The building will contain three stalls, 97 ft. long. It will be a frame

structure with concrete pits and concrete footings supported on piles.

The contracts for 9,000 freight cars for export to Italy are reported about to be distributed by the War Industries Board. The Standard Steel Car Company and the American Car & Foundry Company, who have steel purchased for Russian cars, which orders have been suspended, will, it is said, probably construct the largest number of cars for Italy.

The Central of Georgia has contracted with the General Railway Signal Company for an electric interlocking plant at Macon Junction to replace one recently destroyed by fire. The machine will have 97 working levers and 15 spare spaces. All switch levers will be provided with lever lights, and an illuminated diagram with 23 lights will also be provided.

The Pennsylvania Railroad has awarded a contract to the Roberts & Schaefer Company for a 300-ton reinforced concrete automatic electric locomotive coaling plant and a sand plant for installation at West Brownsville Junction, Pa.; also a 200-ton concrete automatic electric coaling plant and a sand plant at Blairsville, Pa.

The Los Angeles & Salt Lake is receiving 1,000 steel coal cars, which cost $2,000 each. This company is also completing a concrete coal terminal operated by electricity at Provo, Utah; also a store room, roundhouse and shops at a cost of $250,000. At Caliente, Nev., the company is spending $20,000 on a modern coaling station.

Reclaiming Oil and Grease.

It is interesting to note that in the cleaning of machinery generally in Great Britain. the process of reclaiming of oil has reached a degree of economy that is worthy of imitation. The process, after dismantling, consists of placing the parts in a cradle and submerging it in a tank of water with which a jet of steam is turned so as to bring the water to boiling point. Caustic soda is added to the water until a solution of about 3 per cent. strength is obtained. The whole of the grease is removed from the parts in the process of boiling and comes to the top of the water. Before the contents are removed the grease is drawn off the top. This is done through an overflow pipe of large diameter which leads into a barrel.

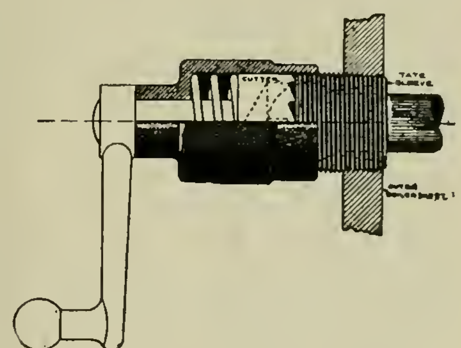
The cradle of parts is then transferred to a second tank of clean, boiling water, which finishes the cleansing and, as the parts are drawn out quite hot, they drain perfectly dry and absolutely clean.

It is claimed that the saving is considerable.

Tate Sleeve Facing Device.

Among the recent new tools used in installing and repairing staybolts is a clever and neat device used on Tate sleeves that are not infrequently knocked about and the cap seats become nicked with slight indentations, or may thus be damaged during application, and these nicks or notches on the sleeve where the cap makes its bearing at times cause leakage.

To obviate the necessity of taking sleeves out of the boiler, the use of the facing tool shown in our illustration may be used. It may readily be screwed over the cap end of the sleeve, and by slightly turning the knurled head until the cutter comes in contact with the sleeve face, by gradually increasing the tension by screwing on, at the same time turning the cutter, the nicks may be speedily removed. Oil or grease should be used for the cutter face when the nicks are removed, determined by the feeling, then release the tension slightly, and one or two revo-



REFACING TOOL FOR TATE SLEEVES.

lutions of the cutter will leave a smooth bearing.

There are tools of a similar character that can be used to refinish cap seats when damaged, by making an end mill, with smooth diameter to fit the tops of the cap threads neatly, with shank to fit either a speed lathe or air drill, or with a square end for wrench.

Lubricant for Cutting Threads.

For cutting threads in copper and even steel, one of the best lubricants is common beeswax. Rub the partially finished threads with a lump of the wax and a clean thread will be cut, provided that the tool is sharp.

A Double Hack Saw.

For cutting soft metal place two blades in the saw frame, one in the usual way and the other reversed so that the teeth will point back toward the handle. One blade will cut while the saw is pushed forward, and the other makes its cut when drawing the saw back. While one blade is dragging it will prevent the other from taking too deep a cut on the metal.

Books, Bulletins, Catalogues, Etc.

Baldwin Record No. 88.

The Baldwin Locomotive Works have issued a catalogue which they call Record 88. It is profusely illustrated with line cuts as well as half-tones. The Santa Fe type or 2-10-2 engines are shown, and an explanatory description accompanies the illustrations. A Portuguese East African engine, also of the 2-10-2 type is given with description and views. The same type as used on the Chicago, St. Paul, Minneapolis & Omaha, is treated in the same way. The 2-10-2 on the Texas & Pacific is illustrated and described. The Duluth, Missabe & Northern have used the 2-10-2 type, and record is made of the fact. The Chicago Great Western, the Union Pacific, the Chicago Burlington & Quincy, the Lehigh Valley, the Southern, the St. Louis-San Francisco, the Bessemer & Lake Erie, the Baltimore & Ohio and the Erie railroads are all illustrated and described with regard to their 2-10-2 engines. The whole gives information concerning this type of power as used on these roads and the reader can get a very comprehensive view of the whole subject by a careful perusal of Record 88 of the Baldwin Works.

Finding and Stopping Waste in Modern Boiler Rooms.

The above is the title of a new book by the Engineers of the Harrison Safety Boiler Works, Philadelphia, and extends to 276 pages, with 213 illustrations, and sold at one dollar per copy. The book is the result of experiments and tests and is divided into five sections, the first being devoted to "Fuels," under which are considered the coals of the United States and their classifications, size of coal, coal sampling, proximate analysis, ultimate analysis, heating value of coal, ash and clinker, value of coal for steaming purposes, purchase of coal under specification, washing of coal, storage and weathering of coal, coal measurement, oil fuels and gaseous fuels.

The second section is on "Combustion," taking up the chemistry of combustion, air theoretically required, grates and grate surface, hand-firing methods, thickness of fire, mechanical stokers and their operation, furnace temperature, furnace gases, clinker, draft, flue and stack proportions, draft required by stokers, mechanical stokers, draft gages, dampers, flue gas temperatures, flue gas analyses.

The third section treats of "Heat Absorption," including heat transmission by conduction, convection and radiation, heat transfer from a fluid in a channel, heat transfer in economizers, air heaters and superheaters, improving heat absorption, relation between heating surface and boiler capacity, boiler setting, refractories and fire brick, soot, scale, softening feed water, and feed water heating.

The fourth section, on "Boiler Efficiency and Boiler Testing," covers heat balance, heat absorbed by boiler, heat losses due to moisture in the coal, hydrogen, chimney gases, combustible in the ash, moisture in the air, and unaccounted for loss, efficiencies, efficiencies with different coals, boiler capacity and efficiency, and boiler trials.

The fifth section, on "Boiler Plant Proportioning and Management," discusses various arrangements of auxiliaries with regard to their effect upon feed heating, and also describes the Polakov functional system of boiler room management.

Staybolts.

Last month's issue of *Staybolts* contains a continuation of instructions in the application of parts with a series of illustrations of the tools necessary for the proper installation of the Tate flexible staybolt. The descriptive matter accompanying the illustrations show the absolute necessity of the use of the tools, more particularly in those parts of the boiler where the outer and inner sheets are not parallel to each other. Where continued tightness of the joint is a primal necessity a perfect fit cannot be expected unless pains are taken that a correct alignment of the bolt holes is made, and this largely depends upon means being used to adjust the cutting tools so that the staybolt shall be attached at right angles to the inner sheet. Full particulars are furnished of the right way and wrong way of doing the job, and the tools desribed and illustrated are the outcome of practical experience. Send for a copy of Vol. 5, No. 4, to the Flannery Bolt Company, Vanadium building, Pittsburgh, Pa.

Lubricating Engineer's Handbook.

J. B. Lippincott Company, Philadelphia, has published a book on the above subject, by John R. Battle, M. E., extending to 333 pages, with 161 illustrations, tables and charts. It embraces descriptions of the various kinds of oils, greases and lubricants, and manner of testing the same. The different kinds of bearings and the particular problems attending the lubrication of each are shown. There are also descriptions of various machines, with numerous suggestions, recommendations and ideas looking to better service with the machines in use and for the use of the most suitable lubricant for each purpose. To those interested in the means and methods of lubrication the book is of real value.

The Nation's Call to Railroad Men.

Hon. William G. McAdoo, Director General of Railroads, has issued an earnest appeal to all officers and employees of the railroads of the United States to apply themselves with new devotion and energy to the work of keeping trains moving on schedule time and to meet the demands upon the transportation lines, so that our soldiers and sailors may want for nothing that will enable them to fight the enemy to a standstill and win a glorious victory for America and the Allies. Fair treatment is assured to every employee, and the appeal is endorsed by Mr. Samuel Rea, president of the Pennsylvania Railroad and is published in the form of an illuminated poster and prominently displayed where all the railroad men may have an opportunity of reading the timely and eloquent appeal.

Reactions.

The current issue of *Reactions*, published by the Goldschmidt Thermit Company, 120 Broadway, New York, contains an excellent article by T. O. Martin in regard to a new field for the use of thermits. The article describes at length the making of a reamer by inserting the finished blades in a cylinder the same size and taper of the reamer, with the cutting edges against the wall of the cylinder. With a carbon steel core in the center, and the use of beeswax a perfect matrix is formed to be placed in a regular mold for welding. The job may be quickly and efficiently done. A number of clever operations are also described and illustrated in connection with fracture on parts of locomotives, all of which cannot fail to be of interest to railroad men engaged in repair work. Copies of the publication may be had on application to the company's main office, New York.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXI | 114 Liberty Street, New York, March, 1918 | No. 3

British-Built Ambulance Train for U. S. Soldiers in France

Result of Experience Shown—All Necessaries Provided—Train Intended for Special Purposes, Properly Designed—Good Work Well Done

By ROBERT W. A. SLATER

This train is of special interest to us, as our half-tones illustrate a new ambulance train recently completed by the Midland Railway of England, at their carriage and wagon works, Derby, for service with the American Expeditionary Forces in France.

The train comprises in all sixteen coaches, with accommodation for about four hundred and thirty persons. In general design, both exterior and interior, British practices are followed. The total length of the train, without locomotive and tender, is 913 feet and the weight, empty, is 455 tons. Westinghouse brake equipment has been installed. Special care has been taken that the cars may be kept clean with the least effort. Floors are covered with linoleum and have rounded corners. Roofs are semi-elliptical with lofty and airy ceilings.

Each car is well built and painted khaki color, like that of the soldiers' uniforms. The car color is without relief save for two large red crosses on a white ground on either side.

The use of what is usually called the Red Cross to designate ambulance service in the field and in hospitals, had its origin in an international council held at Geneva, in Switzerland, in 1863. At this conference the so-called "humane" practices on the battlefield were discussed, and field and permanent hospitals, ambulance service, and the many humane methods of caring for the wounded, were officially recognized by the signatory powers. How far the German government has departed from its own voluntary and solemn pledges in the present war of brutal outrage on land and cruel piracy at sea, is a matter of common knowledge. At the time of the conference all seemed well and a badge was devised as the distinguishing mark for this noble form of service. The flag of Switzerland is a white cross on a red ground, the arms of the cross not reaching the borders of the flag. As a compliment to the land where this humane work was sanctioned, the flag of Switzerland was taken as the design with the colors counterchanged, making it a square "Geneva" cross in red, charged on a white ground. Thus does the "red cross" come to be the symbol of Christian toleration and service to friend and foe, on the field of strife and bloodshed.

This ambulance train is vestibuled and fitted throughout with electric lights and fans. The roofs are semi-elliptical, with lofty ceilings. The gangways between cots are wide enough to allow the carrying in or out of the army stretchers. Apart from the drinking water reservoirs on the cars, a supply of 2,835 gallons is carried in tanks built on the roof.

The order of the cars on the train is as follows, and for identification purposes the number of each car and the distinguishing letter are conspicuous on each side: A-10, brake and "lying" infectious ward car; B, staff car; D-1, kitchen car, with officers' compartment; A-1, A-2, A-3, A-4, ward cars; F, pharmacy car; A-5, A-6, A-7, A-8, A-9, ward cars; D-2, kitchen car (with N. C. O.'s and men's compartment); C, personnel car; E, brake and stores car.

BRITISH-BUILT AMBULANCE TRAIN FOR U. S. SOLDIERS, "OVER THERE."

Car A-10 contains four wards, an attendant's compartment, with toilet, and guard's compartment with bed, folding table, seat, lavatory, etc., in addition to the usual brake equipment. Each car is 54 feet long and mounted on four-wheel bogies or trucks, as we would say. The couplings, drawhooks, steam connections and side chains are made to conform to

the international standard. The staff car contains a dining-room, and also sleeping accommodation for medical officers and for nurses. Kitchen car (B-1) has an officers' pantry and cook's room, with three sleeping berths.

THE WARD CAR. BRITISH-BUILT AMBULANCE TRAIN FOR U. S. SOLDIERS.

The kitchen, which is a spacious compartment, is fitted with an army "Dixie" range, and a "Soyer" stove, while a comfortable sitting room for "sick" officers forms a part of this car. The pharmacy car has a dispensary and a "treatment" room, with medical officer's quarters, linen room, a pantry for medical comforts, and an emergency compartment. Personnel car C is arranged similarly to the nine ward cars, except that the mattresses of the beds are upholstered in American cloth, so that they can be used as seats for the official staff during the day.

Brake and Syores car E, contains a large linen store and a compartment in which are shelves for carrying general provisions, a kit store, a compartment for perishables and a meat safe, and brake equipment similar to that on car A-10, completes the vehicle. First in the train is the brake and infectious ward car, which contains four wards each, fitted with six beds.

Next is the staff car for the officers, with dining room and sleeping compartments and lavatory and toilet accommodations, including side sprays. This car is furnished with wardrobes, cabinets and bookracks, and is finished and paneled throughout in polished mahogany. The ward cars are open throughout, with a lavatory compartment at one end. Each car contains thirty-six folding cots in three tiers. An ample supply of drinking water and conveniences, such as paper racks and ash trays, is provided for each patient. The sides and roofs of these cars are painted in glossy white enamel. The last car in the train is the brake and store car, and has plenty of linen. Each car is fifty-four feet long, and is built of well-seasoned timber. The whole train is a fine example of the car-builder's art, and all that the years of war experience has given to the British nation is embodied in the units of this train. Its neat appearance and its conspicuous "red cross" proclaim it as having emanated from a business people engaged in the business of war, yet humane, though fearless, and as a tribute to America's efforts to let the Anglo-Saxons stand strong together until victory is ours.

THE PHARMACY IN THE BRITISH-BUILT AMBULANCE TRAIN FOR U. S. SOLDIERS.

Proper Use of Oil on the Road.

There is a bad practice sometimes resorted to by trainmen, when a hot box makes its appearance. These men go to the engine and get a piece of rod cup grease, or driving box compound, and put it into the troublesome box on top of the waste probably on both sides of the journal. The box very likely cools off, but if the waste and grease are not removed at once, after the journal has cooled down, and the box be at once repacked with saturated waste in the regular manner, it is almost sure to run hot again in a very short time. The reason for this is that while it is hot it plasters the surface of the packing with a hard, gummy coating of grease so that the oil that is still held in the waste beneath and ready to lubricate, cannot get up through it to the journal, so that when the oil supply is thus shut off after the grease is worn out, it gets hot again.

Large oil manufacturing concerns have expended great sums of money in building laboratories, which are superintended by expert chemists who work to combine the best materials of various kinds of oil, keeping in mind the kind of work the oil is expected to do. If, for example, engine oil and valve oil are mixed together, the unity of each is destroyed, or so altered, that very much less satisfactory results follow than if they were used separately. Everyone concerned should know what the different kinds of oils are and understand what they are intended to be used for. Valve oil is for the lubrication of valves, cylinders and air pumps of the locomotives. Engine oil is for the valve gear and engine trucks, and other oils for other purposes. Oil should not be applied to boxes or to crank pins prepared for grease when they are running hot.

Safety Devices for Overhead Cranes

Safety Devices in Use—Can Be Applied to Existing Cranes—They Save Life and Limb and Preserve Valuable Property

OVERHEAD SHOP CRANE WITH LATTICE GIRDERS AND SAFETY DEVICES.

Makers of electrically operated overhead cranes for locomotive repair shops are now-a-days provided with special safety devices. In fact electrically operated machinery is generally so fitted, and it seems that the use of the electric current lends itself to the adoption of devices for preserving life and limb. In the matter of overhead traveling cranes for shops, all alternating current cranes have two brakes: a solenoid and a mechanical brake. The solenoid brake is attached direct to brake wheel on the hoisting motor and goes into operation whenever the current is shut off either by the controller's break of the line circuit or from some other cause.

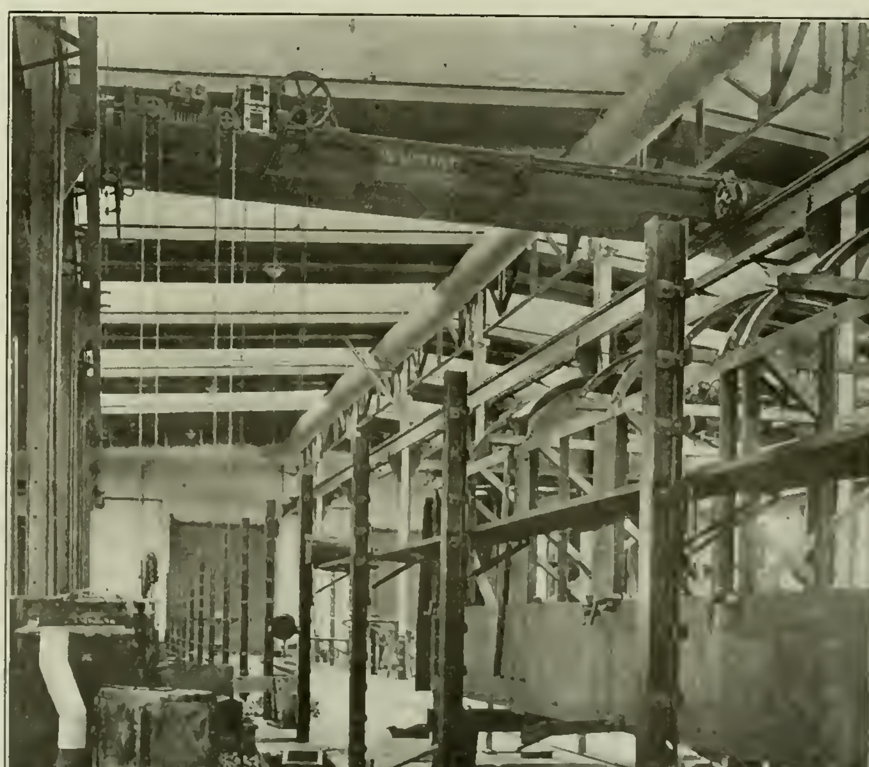
This brake in itself has sufficient capacity to hold the full load when the current is cut off. The mechanical brake is installed in the gear train and is used to prevent any acceleration of the load, when lowering. The Whiting brake for instance is so designed, that if anything should happen to the solenoid brake or motor, or even to the gear train, back of the mechanical brake, the load would be held from dropping by the mechanical brake alone. This is a very important safety feature and is considered an excellent feature by all crane users. The limit switch is so designed that when the block reaches the danger point in hoisting, it strikes a paddle, which, when raised 1/16 in. or more, will shut off the current from the hoisting motor.

The wiring is so designed that no movement, except a lowering movement, can be obtained after the limit switch has been thrown. On old designs when the limit switch was raised or thrown out, a circuit breaker went out. If the operator did not throw his controller back to the neutral point, and turn to his switchboard to replace the circuit breaker, the hoisting would continue and cause as much damage as though no limit switch was in the circuit.

This is now impossible with this later design of switch, because it is absolutely necessary for the operator to throw his controller back to the neutral point, and then to a lowering point, before any motion whatever can be obtained in the hoisting equipment.

This is a design that crane users have required for many years as it is absolutely fool-proof. On some high-speed cranes the momentum of the gears often allows the block to travel a slight distance higher after the switch has been thrown. This is now overcome by placing, on the shaft of the main limit switch rod, a heavy coil spring. When the switch is thrown, the block comes in contact with spring, which holds it down, and so stops momentum of the machinery. Altogether these safety features are well worthy of careful study and of adoption by any prospective crane user who is contemplating the adoption of an overhead crane, or these features can readily be adapted to existing cranes.

The idea of automatic safety and mechanical security is practically "in the air," at the present time, and this as it should be, for the sanctity of human life, so wantonly sacrificed in war, needs preserving as it never did before.



OVERHEAD SHOP CRANE WITH MECHANICAL SAFETY DEVICES WHICH PREVENT SUDDEN SLIPS OR AN OVERWOUND DRUM.

Lubricating Air Compressors

What Is Required in Lubricating Air Cylinder of Compressor—Quality of Oil an Important Item—Minimizing the Danger of Explosions—Carbonizing of Oil Objectionable

The important subject of lubricating air compressors was dealt with, not long ago, by a member of the Texas Company, who read a paper before the Lubricating Engineers' Association. His remarks are here quoted, not necessarily word for word, but in substance he said:

In general, air compressors may be divided into two classes—the single cylinder, single stage type, and the multi-stage type. In the single stage type the air is compressed in one cylinder and in one operation, while in the multi-stage type the compression is reached by two or more stages. The single stage compressor is the one in most common use and generally operates under a pressure of from 50 to 60 lbs. to the square inch.

The compression of air results in the conversion of the energy used, into heat. The rise of temperature of a volume of air under compression follows certain laws, and tables have been compiled which show the theoretical temperatures the air will attain when compressed to certain pressures. The following table gives the temperature that air will attain, taking the inlet at 60 degs. F.

Gauge Pressure.	Atmospheres.	Final Temperature.
0 lbs.	1.	60 Deg. F.
25 lbs.	2.7	234 Deg. F.
50 lbs.	4.4	339 Deg. F.
75 lbs.	6.1	420 Deg. F.
100 lbs.	7.8	485 Deg. F.
125 lbs.	9.5	540 Deg. F.
150 lbs.	11.2	589 Deg. F.
200 lbs.	14.6	672 Deg. F.

In actual practice the temperatures never reach these figures for the reason that it is important that the temperatures be kept low. A large amount of the trouble with single stage air compressors, when examined, have shown that it is due to the fact that they are overloaded. Where the air is compressed through more than one cylinder, the temperature of the air is still further reduced by passing it through intercoolers on its way from one cylinder to another. These intercoolers connect the air discharge of the first cylinder with the inlet of the second cylinder. The final discharge from a multiple cylinder compressor is often cooler than from a single cylinder compressing to only 80 or 100 lbs. pressure, especially where the single stage machine is run at high speed. The external lubrication of air compressors does not differ from ordinary external lubrication. After passing through the bearings the oil is returned to the crank case and is used over and over.

In design and construction the air compressor of the piston type is similar to a steam engine. The action, however, is the reverse, for in the case of the air compressor cylinder, power is transmitted to the piston. In a simple form of compressor the air in front of the piston is compressed until the pressure reaches a point sufficient to open the discharge valve, and the charge of air is then forced into the receiver through the outlet pipe. In the meantime a partial vacuum has been formed in the cylinder back of the piston which has caused the inlet valve to open, admitting air at atmospheric pressure, so that at the end of the stroke the cylinder is filled with free air for compression upon the return of the piston. The action of both the inlet and outlet valves is entirely automatic, the former opening inward and the latter outward when the pressure on the two sides becomes unequal.

As in the case of steam cylinder lubrication, the conditions of the internal surfaces, the piston speed, and the weight and fit of the piston must be taken into consideration in selecting the proper air compressor oil. Low speeds and heavy or loose fitting pistons require a higher viscosity of the oil than high speeds and light or tight fitting pistons. Other important factors which govern the lubrication of air compressors are the degree to which the air is to be compressed, the location of the air inlet, the method of applying the lubricants, the kind of valves used. Vertical compressors do not require as much lubricant or as heavy a lubricant as horizontal compressors.

One of the most important requirements of an air compressor oil is that it should have a viscosity sufficiently high to meet service requirements. For high pressures and temperatures an extra heavy viscosity oil, such as Texaco Ursa oil or even Vanguard Mineral oil should be used. For medium pressures and temperatures a heavy viscosity oil, such as Texaco Algol oil, and for low pressures and temperatures a medium viscosity oil, such as Texaco Alcaid oil or a light viscosity oil such as Texaco Cetus oil should be used. The oil should have sufficient body to sustain the weight of the moving parts, to form a seal between the piston rings and the cylinder walls, and to prevent the excessive use of oil. On the other hand, the viscosity should not be too high to obtain efficient atomization or to cause excessive friction. Moreover, if an oil of too great viscosity is used, it will tend to collect any dust that may be in the air and will tend to bake on the hot surfaces and form carbon deposits. This is especially likely to happen when more oil has been used than is just sufficient to lubricate the wearing surfaces.

Another requirement of air compressor oil is that it should not be decomposed under the heat conditions to which it may be subjected in the cylinder, resulting in the formation of carbon. The chief objection to steam cylinder oils is that they easily decompose under air compressor cylinder conditions, and form sticky and hard carbon deposits in the cylinders and valves or air lines. Carbon deposits are probably the chief cause of air compressor explosions. They also hinder the working of the valves and by increasing the friction cause an increase in the temperature of the air. Carbon also has a tendency to cause bad cutting of the valves and valve seats, which can result in a considerable amount of damage in a short time. The amount of carbon formed with Texaco Ursa, Algol, Alcaid or Cetus oils is small, due to the fact that they do not readily decompose; and any deposit which is formed is of a dry, sooty nature, which does not collect dust or accumulate in the cylinder or on the valves.

One of the troubles commonly met with in compressors is the groaning of the pistons. Generally this can be traced to an improper fitting of the piston rings, which, being subjected to alternating pressure, set up a vibration which allows the air under compression to leak by the piston rings in an unsteady flow. This, in turn, increases the vibration of the rings and results in the groaning of the pistons. This condition exists in compressors that have been in use for a considerable time without renewal of rings, and it can frequently be overcome by using a higher viscosity oil.

In steam cylinder lubrication it is necessary that the oil be atomized or broken up into small particles so that it will be carried by the steam to the surfaces to be lubricated. The same is true, to a certain extent, in air compressor lubrication, in which case the oil should be atomized by the incoming air, and carried to the surfaces of the cylinder walls and to the valves. As in the case of steam cylinder lubrication, the atomization becomes more complete with an increase in distance between the point of introduction of the oil and the valve chest.

Ordinarily the oil is introduced into the

air compressor at or above the point of air intake.

The greatest efficiency is obtained by the use of automatic lubricators, and many types of compressors are now equipped with these lubricators. In many cases of steam driven compressors two-compartment lubricators are used for feeding two kinds of oil, one to the steam cylinders and the second to the air compressor cylinders. These lubricators insure a uniform rate of feed irrespective of any changes in the air pressure.

It is impossible to make any hard and fast rule as to the proper amount of oil to use in a compressor. Trouble experienced with air compressors is probably more frequently due to the use of an excessive amount of oil than to any other cause. The amount of oil necessary to lubricate an air cylinder is usually about one-third or one-fourth the quantity required to lubricate a steam cylinder of the same size. If the lubricant is unsuitable, an excessive amount is required to keep the cylinders from groaning, and the result of the use of an excessive amount of oil is carbonization in the air passages, and particularly on the discharge valves. Sticking of these valves allows hot compressed air to flow back into the compressor cylinder. This is a sign of too much oil. The discharge valves should be examined regularly, and the receiver and discharge pipes blown out.

Another cause of complaint has been found to be due to the use of unsuitable oils, such as compounded steam cylinder oil, in the air compressor. These oils, besides being very viscid, contain much free carbon matter, which clings to the orifices of the discharge valves and seats, gathering dirt from the air. Under the influence of the dry heat, together with the dirt from the air, these oils soon become carbonized and form a hard, flinty substance that requires considerable labor to remove, while the animal oil used in compounding separates and forms a sticky residue which under dry-heat conditions decomposes, liberating a free fatty acid. This will honeycomb or etch the cylinder and piston surfaces and also make the piston rings more brittle.

One of the lubrication engineers reports a series of tests which he conducted to determine the effect that heat would have on various lubricating oils when subjected to high temperatures such as exist in an air compressor cylinder. He says the best way would be to test the oils in the cylinders of an air compressor, but as in most types of compressors the valves are in one large heavy casting, which, with the water pipe connections, make them difficult to remove, not many engineers care to go to the trouble of doing it.

He devised a plan whereby he could determine approximately the action of different oils under heat conditions somewhat similar to those which exist in an air compressor cylinder. This was accomplished by taking a block of cast iron about 6 or 8 ins. square and 2 ins. thick and placing it on a layer of dry sand in a shallow iron pan, packing the sand close around the cast-iron block, and placing the pan over a gas burner. The upper surface of the block was polished and a hole about ½-inch deep drilled in it, large enough to hold a mercury bulb, cylinder oil was poured into the hole so as to make a close heat contact.

Air, taken at a temperature of 60 degs. Fahr., and compressed to 125 lbs. per square inch gauge pressure, will theoretically attain a temperature of 540 degs. Fahr.

When the thermometer showed 400 degs. Fahr., a certain oil was taken that had been used at a certain compressor plant. It was a very light bodied, paraffine base oil, like a spindle or ice machine oil. A drop of this oil was allowed to fall from the point of a lead pencil from a height of 2 ins. onto the block. In 10 seconds it had spread out to a circle of 1⅛ ins., smoked slightly, and dried up almost instantly, thus indicating that it was a very poor compressor lubricant. Then a drop of a slightly heavier oil, such as would be suitable for use in turbine and motor bearings, was tried. This spread out quickly to a diameter of 1½ ins., smoked slightly and dried up in two minutes. It was but little better than the first oil. A still more viscid oil, like a medium bodied engine and machine oil, was then dropped on the hot surface. It spread out slowly to a diameter of 1¼ ins.., smoked slightly, and the surface was oily after five minutes. In the meantime the temperature, as shown by the thermometer, had gone up to 420 degs. Fahr. A still heavier oil, such as is usually used in gas engines, did still better, even after the temperature had gone up to 450 degs. Fahr. It smoked but little, and a good trace of oil was still on the block after 10 minutes. A steam cylinder oil was then tried. It did not smoke or dry up, but after a while it became thick and gummy.

Even at the highest temperatures the engine oils burned up clean, leaving no trace of dry coke or carbon matter, which tends to confirm the theory that the hard formation often found in and around the discharge valves of air compressors is due largely to the presence of dirt in the air, which adheres to the oily surfaces, and which, under the continuous dry heat, becomes baked and burnt on.

The deductions that may be drawn from these crude tests are that for such temperatures as would be encountered in a single stage compressor, compressing to 125 lbs., a high-grade filtered mineral oil of moderately high vaporizing point, suitable viscosity, and especially low in carbon content, will give most economical results. If such an oil is used in moderate amounts, and if the air inlet is properly placed, no trouble will be experienced with lubrication.

The location of the air inlet on an air compressor is of great importance, and extra care should be used in placing it. It is surprising what a large amount of abrasive material can be passed through a compressor without the cylinder walls or valves being scored. Troublesome conditions usually develop from a continuous circulation of abrasive matter in the air in the valve gauges, where it accumulates with oil which adheres to the surface of the valves, and eventually becomes carbonized from continuous subjection to the temperatures caused by the compression of the air.

The lubrication of the air compressor constitutes an important part of Diesel engine lubrication. In the Diesel engine the gases of combustion are exhausted after the power stroke and the cylinders filled with fresh air which is compressed by the piston on the up or out stroke.

These compressors are of the multiple stage type, in which the air is compressed successively through two or three cylinders. In the first cylinder it is compressed to 40 to 80 lbs., in the second cylinder to 200 to 300 lbs., and finally in the third cylinder the pressure reaches 800 to 1,100 lbs. per square inch. As the air passes through intercoolers in its passage from one cylinder to another it reaches its maximum pressure in a comparatively cool state. The air then passes to containers which allow any moisture that the air may contain to precipitate and also acts as a storage reservoir to draw from when starting the engine. These compressors are usually connected directly to the main engine shaft and form a part of the engine in a stationary plant.

Air compressors exposed to weather conditions, such as those used on electric railway cars, require a lubricant for winter use which has a low cold test. The Texaco air compressor oils are low cold test oils, and will meet all temperature requirements.

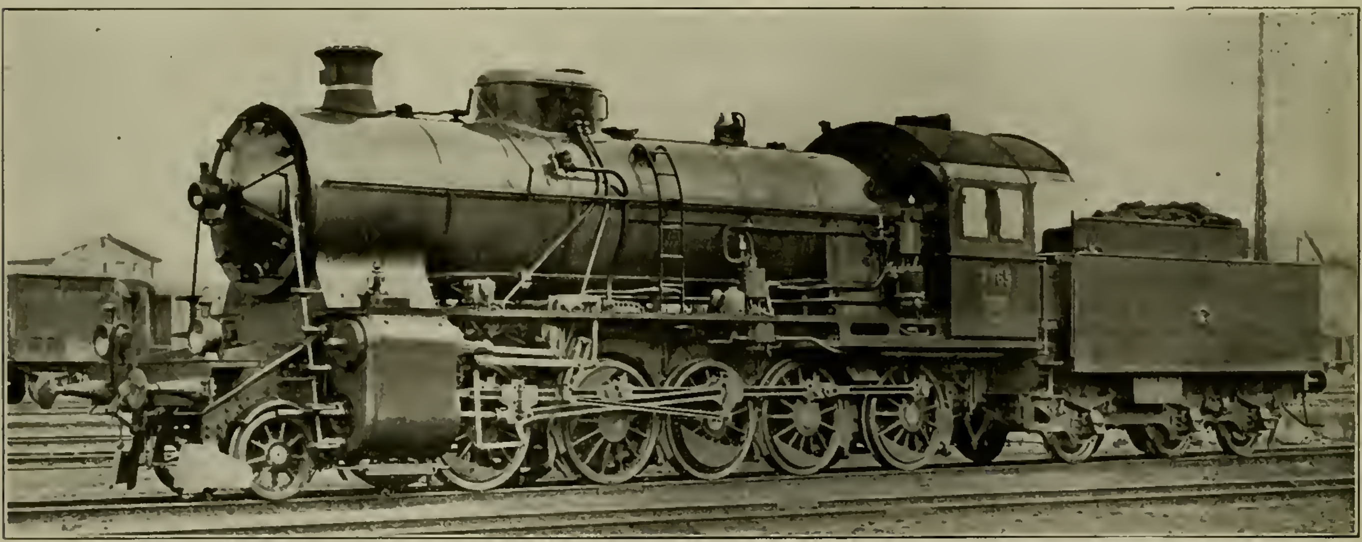
While air compressor explosions occur at rare intervals, the fact should be emphasized that properly operated and properly cared for compressors are as harmless as steam engines. The theory that these explosions are due to the use of an oil with a comparatively low flash point is discredited, as the explosions occur more frequently where a high flash oil is used. It is also generally agreed that the explosion is due to the accumulation of carbon deposits in the air lines. This deposit in turn is caused either by the use of an unsuitable oil which decomposes, or to the use of an excessive amount of oil, or to the improper position of the air inlet. The belief that the explosion is always produced by the ignition of a volatile mixture usually of vaporized

oil and air, though possibly of coal dust and air, in the air tanks or lines, is questionable in view of the fact that the small amount of oil volatilized in the air compressor cylinder would be insufficient to form an explosive mixture with the air, as this volatile matter is constantly being carried off with the air. It could only be in a case where an excessive amount of oil was used or where pockets of oily residue were allowed to collect that a sufficient amount of vaporized oil could collect to form with the air an explosive mixture. Even in such a case the cause of the explosion would not be the vaporized oil, but would be some other factor which produced a spark or flash. The probable source of this spark is again the carbon deposit, which may be responsible for a sufficient increase in temperature, by restricting the air passage and thus increasing the pressure so as to cause the carbon to become an incandescent mass. It is not improbable that in some cases this glowing mass of carbon may weaken the tensile strength of the air receiver or the air lines to such an extent that they are no longer able to withstand the pressure of the air, the result being an explosion.

Swiss Decapod Type of Locomotive on the Paris, Lyons and Mediterranean Railway

Originally Intended for the Gothard Section of the Swiss Railways

A correspondent in Switzerland who is very much interested in the general good that is being effected by locomotive feed water heaters has sent us a photograph of a Decapod or 2-10-0 engine built by the Swiss Locomotive Works at Winterthur in 1916. These engines were intended for the Swiss Federal Railways, Gothard Section (Class C. 5/6).



DECAPOD 2-10-0 TYPE LOCOMOTIVE FOR THE PARIS, LYONS AND MEDITERRANEAN RAILWAY.

By some international agreement these engines have, during the German war, been used in helping service in France on the lines of the Paris, Lyons and Mediterranean Railway. The engines shown in our half-tone, made from the photograph received, are powerful machines, being of the four-cylinder compound goods type fitted with superheater and with the Schichau feed water heater.

The dimensions, which are given according to the metric system, are high pressure cylinders 470 mm. Low pressure cylinders 710 mm. Stroke 640 mm. The diameter of the driving wheels is 1,330 mm. Rigid wheelbase 2,900 mm. Total wheelbase 8,800 mm. Boiler pressure 15 atmospheres. Grate area 3.7 m—². Heating surface 265.2. Weight on driving wheels 76.1 tons. Weight in working order 85.8 tons. Tender 18 m—³. Coal 7 tons. Weight empty 16.2 tons. Weight in working order 41.8 tons. Total weight in working order, engine and tender, 127.6 tons. Total length in working order of engine and tender 19,195 mm.

When compared with an engine not equipped with feed water heater, this engine using the Schichau system on the newest Decapods which we here represent, when in ordinary service on the Swiss State Railways, give a coal saving (so it is stated) of from 10 to 12 per cent. on the Gothard line where they ran before being taken for pusher service on the P., L. & M.

A Strange Kind of Old Railway

The history of railway operation in this country is full of many curious and interesting details. Among them none are stranger than those that concern the Memphis, El Paso & Pacific Railroad, a forty-mile road operated between Marshall, Tex., and Shreveport, La., during the Civil War.

The owner of this line was Mr. John Higginson. The motive power was the best of its kind in those days, and consisted of several yoke of oxen, commonly known as "hay-burners."

Mr. Higginson ran his train on a tri-weekly schedule. When he had gathered up a "cargo" and everything was ready for the trip he loaded the oxen into the first box car in the train. In the next car he put the freight and the passengers, and in the third he himself rode. The cars started down the steep grade out of Marshall and, after they had run as far as they would, Mr. Higginson set the brakes and proceeded to unload the oxen and hitch them to the coupling of the car. Then he released the brakes and started the train up the grade. At the top the oxen were again loaded into their car and another start was made down hill. By repeating this operation several times Mr. Higginson and his train would finally reach Shreveport.

The passenger rate was 25 cents a person. Freight charges were anything the owner of the line could get. Since there was no competition, Mr. Higginson made money. All freight was marked "red ball" and handled as soon as received.

The Business Box Car

At a recent meeting of the Western Railway Club, Mr. W. J. Bohan, mechanical engineer of the Northern Pacific, read a paper on "The Business Box Car." In this paper, a synopsis of which we give, Mr. Bohan dwelt on practical business judgment, based on experience, and accurate technical information. Continuing, he said, among other things:

The most economically efficient box car, is one in which every detail, even the grab irons, are made to do their share in assisting the proper uses of the car and resisting the abuse to which it is exposed in everyday life. The body of such a car should not be built around any one member, but all of its members should form a unit, having maximum inherent strength and resilience, and acting as a unit should act in dissipating all reasonable strain. It should have the fewest possible primary and special parts. Joints, gussets, rivets, bolts and fastenings, which work and wear to the detriment of the car, increase its cost of upkeep, and loss of time on repair tracks should be reduced to a minimum. A general specification for a car that would meet these requirement would be briefly as follows:

The weight for, say, a 40-foot, 40-ton box car should be between 45 and 50 per cent of the stenciled capacity. It should not exceed 48 per cent. This weight can be obtained without sacrifice of strength. In connection with the matter of efficient weight: Electric motor builders design a motor to handle 25 per cent overload for two hours without abnormal stress. There seems to be no reason why box car design should not be designed upon some such basis. It is to be understood that a 25 per cent overload rating is not the correct rating for a box car.

The body of the car should be a steel frame throughout, preferably pressed steel of resilient quality. The underframe, sides, ends and roof should be diagonally braced throughout. There is no question about the efficiency of diagonal bracing. Its value has been many times demonstrated in the reclamation of old cars. As the diagonal bracing of the entire construction will distribute the strains due to the live load and the shocks to all members of the car, the fish belly type of center construction is not necessary. Ten-inch center sills of ordinary cross-section are sufficient.

Side and end posts and braces at the points of attachment with sills and plates, underframe bracing at the points of attachment with center and side sills, and roof bracing at the points of attachment with ridge pole and plates should be directly connected, that is, the usual construction using gusset plates or other secondary members should be eliminated as the strength and efficiency of the car can be materially increased by so doing and unnecessary parts can be eliminated. Autogenous (electric or oxy-acetylene) welding may be used to advantage in such a construction.

Diagonal underframe bracing at the ends should be securely tied to both center and end sills at their junction, and extend continuously around the ends of the body bolster and cross ties, with alternate connections to the center and the side sills. The same general construction may be followed in the roof for the attachments of diagonal bracing and plates, ridge pole and door carlines. At the door openings the underframe should be substantially reinforced by supplementary diagonal bracing. The plate may be similarly reinforced above the door, or the door track built to form the reinforcement. The roof reinforcement at the door openings may be made by the use of carlines at the door posts. The end construction with its attachment to the end sills and plates is similar to the side construction.

The corner posts should be formed by directly connecting the end side post and side end post members throughout their entire length. This will not only tie the car together securely, but it very greatly assists in forming an integral construction. The corners may be further reinforced by continuous corner and end grab irons.

Side and end sheathing should be made of two sections of sheet steel, their junction should be reinforced by plates, and all securely riveted together, forming side and end girths, the girth reinforcing plate extending continuously from the side door post to the side door post around the end of the car.

End and side lining should be of matched lumber, sides ¾ ins. or 13/16 ins., ends 1¾ ins., the lining extending from floor to plates. The floor may be of the usual 1¾ ins. matched stock, secured to the furring of the underframe, using standard grain strips at the intersections of the floor and sheathing.

The roof should be of the circular type and may be constructed of two sheets (No. 16 steel) running lengthwise of the car, with joint at the ridge pole, the two roof sheets being securely riveted between the ridge-pole and a weather-proof ridge pole. The roof sheets should also be securely riveted to the diagonal braces, end and side plates, thus forming an integral member of the car capable of sustaining its share of the load. It is necessary that the inside of the roof be what is commonly called "non-sweating." This can be had by the application of a heavy coat of ground cork and red lead or mineral paint applied to the exposed metal surfaces. The door should be of steel, framed and sheathed similar to the body of the car, and mounted with weather-proof shields at the posts and plates. The truck should, like the body, have as few parts as possible and be preferably of the cast-steel type.

Particular attention should be given the brakebeam mounting to insure even brake shoe wear and proper alignment of the levers and rods. All these points are of extreme importance not only in that they may perform their special functions properly, but that the irregular transmission of stresses to the car itself be avoided, as far as possible. Brake equipment of the standard makes is quite satisfactory. Special attention, to secure proper application and alignment of parts, is absolutely necessary to obtain safe and efficient results. This special attention is very often lacking.

Draw gear should be of the friction type, having a minimum recoil action, which should be just sufficient to readjust the parts in release. Travel should be approximately 4 ins.. The shock dissipating capacity of the gear should be the maximum obtainable with prescribed travel and standard clearance conditions. The draw lug fastenings should approach strength sufficient to resist maximum shocks regardless of draw gear capacity.

The holes in the framing should be die-punched to templets. All rivets and bolts should be of the best quality obtainable and of full cross-section. Bolts should have properly proportioned heads and clean cut and accurate threads to provide for a good fit of the nuts. Nuts should also be of best quality and manufacture. Application of both rivets and bolts should be made without drifting, rivets having full and concentric heads and driven at the proper temperature. Double nuts, lock nuts, cotters and split keys where used should be given special attention. A good design of nut lock is superior to a cotter or split key on account of the extreme difficulty in getting the proper application of cotters or split keys. No one little thing is a source of more trouble on a car than loose nuts.

Too much stress cannot be placed upon the importance of more careful practical engineering study of both general and detail design to secure a well-balanced resilient car unit. Some manufacturers have done a great deal of excellent work in this direction on underframes, but have not, in my opinion, extended the resilient features far enough, as there is no reason why it should not extend to the entire superstructure of the car. Particular attention should also be given to the selection and assembly of the best obtainable material which is taken from all sources of supply.

Retardation Due to Water Scoops.

Not long ago Mr. H. C. Webster writing to the Railway Review of London, made some very interesting remarks on the subject of the effect of water scooping on train resistances. It appears from what he said that, the resistance caused by taking in water from a trough between the rails, when a train is travelling over it at speed, is larger than is ordinarily supposed, and those who are accustomed to ride on the footplate have, no doubt, noticed the drag that results when the scoop is dropped. Although the amount of water taken varies with the circumstances it is seldom less than 2,500 gallons, all of which has to be lifted about 8 ft. This represents some 200,000 ft. lbs. of work.

During its passage through the trough the scoop becomes a moving vane, and is governed by the same principles as an ordinary turbine is governed by except that the impact in the former case is caused by the collision of the moving scoop against the stationary volume of water, and in the latter case by the moving water against the stationary or slower moving vane.

It follows, therefore, that having its velocity relative to the scoop altered both in magnitude and direction, the water exerts a pressure upon the scoop that takes the form of an added resistance to the motion of the train, and it is this resistance that is considered.

The velocity of the water is altered in direction but not in magnitude. The original velocity being changed to a velocity at right angles to it, equal to a certain amount, by the impressed force that the scoop exerts upon the water. We find by a series of calculations that the relation between resistance and delivery pipe of given area is shown in the following table:

Area in sq. ins.	35	40	45	50	55	60	65	70
Resistance (in lbs.)	1631	1860	2100	2330	2560	2800	3040	3260

velocity taken at 40 miles an hour.

which gives the varying resistances for these train speeds, and from which is plotted the appropriate diagrammatic curve. This curve presents no special characteristics, being regular in form. It is extended above and below the practical limits at which water would be taken in order to obtain a range sufficient to show the nature of the curve.

from which is obtained an appropriate curve, properly plotted. This is here a straight line, and serves to show that a minimum area is desirable in designing the scoop consistent with the volume of water to be lifted over a given length of trough.

In the foregoing the resistances considered are additional to the normal resistance of the train to motion, and no account has been taken of the energy stored in the train as momentum. Here it only reduces the drawbar pull to zero as demonstrated by traction dynamometer. Proceeding in this way with velocities between 25 and 60 miles an hour the following table is obtained, the area being 50 sq. ins.:

Speed (m.p.h.)	25	30	35	40	45	50	55	60
Resistance (lbs.)	901	1310	1779	2330	2940	3610	4320	5220

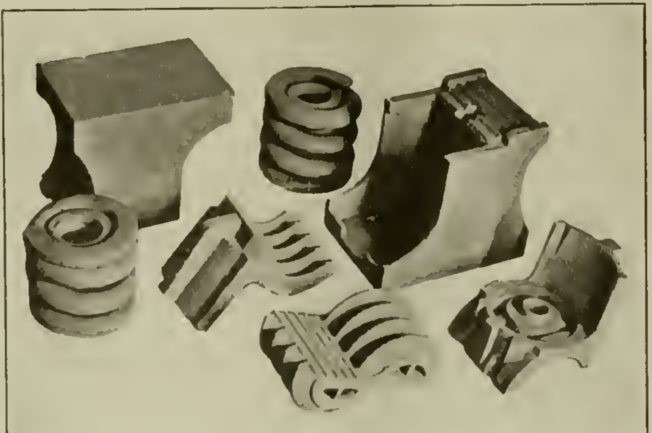
Friction Draw Gear.

The Anderson Friction Draw Gear was first introduced in 1910, and has since been put on a number of cars and engines of various types. The varied character of the service encountered on cars and locomotives has afforded a very searching test of its efficiency and durability under all conditions. The construction of the gear is unique in that its

ANDERSON FRICTION DRAW GEAR.

movement is cushioned by a form of spring resistance transmitted through a rocker, whose leverage increases with the travel, and which is augmented by the frictional resistance of the V-grooved surfaces of the rocker and spring cap, where one rotates in the other.

Its comparative simplicity and its form of construction are shown by a glance at our half-tone illustrations of the various parts which go to make up one gear. There are five steel castings (including the two followers) and two class "G," coil springs making seven parts in all. The principle of operation of the gear is intended to insure a resilient initial action and a positive release, which are two very important considerations in the selection of a draw gear. The breaking of springs and other parts is avoided by designing the follower castings so that they butt solidly at the end of the travel before the springs close. The type "B" gear is interchangeable with other standard friction gears, taking the standard M. C. B. sill-spacing 12⅞ ins. and using a yoke 9⅛ x 24⅝ ins. It has a capacity of 350,000 lbs., and 2¾ ins. travel.



PARTS UNASSEMBLED OF THE ANDERSON FRICTION DRAW GEAR.

To Blacken Small Iron or Steel Parts.

Dissolve 10 weight parts of copperas in twice the weight of water, also 15 parts of chloride of tin, adding 20 weight parts of hydrochloric acid and diluting the mixture in about 400 parts of water. The articles are immersed in this bath for 10 seconds, and after being rinsed in water are ready for a second bath composed of 3¼ lbs. of sodium hyposulphate, generally known as "hypo," to which has been added 1/6 lb. of hydrochloric acid and 2 1/5 lbs. of water. This second bath is produced by first dissolving the hypo in hot water, and the hydrochloric acid should not be added till the bath is to be used. There is a strong visible action when it is poured in, and a yellow precipitate is formed, which should be removed from the solution by filtering through muslin. Small iron and steel parts treated this way will, when dried, be of a bright, black, enduring surface. The immersion in the second bath need not exceed three minutes in duration.

Nickel Plating.

Light nickel-plating can be readily accomplished by heating a bath of pure granulated tin, argol and water to boiling and adding a small quantity of red-hot nickel oxide. A brass or copper article immersed in this solution is instantly covered with pure nickel.

British Railways and the Board of Trade

At a very early date in the history of British railways, Parliament conferred powers on the Board of Trade to inspect new lines previous to their opening for traffic, and to withhold their sanction of the line being opened if anything which might be required by the Board of Trade inspecting officers to be necessary and requisite for safety was not provided.

The first act of Parliament, giving this power to the Board of Trade, appears to have been passed in 1840, and, in addition, railway companies were required to make returns of traffic and accidents, to submit their by-laws for approval, &c.

The Board of Trade requirements now in force apply to all lines on which passenger trains are run and to the junctions of lines for working freight trains only with lines over which passenger trains run, and for the guidance of the railway companies, the requirements are set out in detail. Apart from the question of the degree of safety reached by the observance of these requirements, there is the fact that they have a certain standardizing effect on the equipment of all railways, a consideration of some value in view of the great amount of running of one company's trains over another company's line. It may be mentioned that the Board of Trade also have power to inspect alterations of any importance, due either to extra accommodation, or to reduction of existing accommodation, or renewal.

The Block Telegraph is used to insure a proper space interval between trains, except in the case of a single line worked by only one engine in steam carrying the train staff (usually a wooden token). This, of course, is not insisted on if some sort of automatic signalling is provided instead.

The Signals are home and distant for each direction. These must be provided at every block or signalbox. Starting signals are required for each direction at all passenger stations which have signal boxes. Almost every station has one or more signalboxes, but a few (mostly in sparsely populated districts) have not. Wayside halts on both single and double lines seldom have signalboxes. All crossovers and connections between passenger and goods lines must be protected by signals. This also applies to sidings, except on single lines where the points are unlocked with the train staff or tablet. Signals at junctions must be placed on separate posts or on brackets. Distant signals must be distinguished by a notch cut out of the ends of the arms, and if placed on the same post as a home or starting signal, they must be controlled by such home or starter, so that they can never show an All Right signal when the home or starter is at danger. When in such a position, both applying to trains proceeding in the same direction, they must be fixed under the home or starter.

For sidings, either a disc signal or low short arm and small signal light to be provided, distinguishable from the arms or lights provided in running signals (i. e., controlling fast moving traffic). In practice, however, it works out that these signals are sometimes as high as 20 ft., where a number of arms directing to a number of routes from a siding or group of sidings are placed on the same post, one above the other. Every signal arm must be so constructed that if any portion of the mechanism were to break the arm would fly to danger, and this is obtained by the spectacle side of the arm being made heavier than the semaphore. The lights of signals should be Green for all right and Red for danger. Some modification has of recent years been made in the lights of distant signals on certain sections of lines, yellow being used, but this practice, even in new work, is at present by no means universal.

The backlights of signals when at danger, should be White and as small as possible, having regard to their being visible either from the signalbox or anywhere else where the indication of the arm is of value.

Electrical indicators, showing the position of the arm and whether lamp is alight or not, of any signal out of sight of the signalbox, are also required. The lights of disc or dwarf signals are white when in the danger position, instead of red, except where the signals control movements from sidings to running lines or in and out of running loops.

Facing points must not be placed more than 250 yards from the box and the detection of the switch blade plunger is necessary if over 200 yards away. Trailing points may be 300 yards away. In order to insure that facing points are in their proper position before the signals leading over them are lowered, detectors showing the position of the switches must be provided. To guard against facing points being shifted when trains are passing over them, they must be fitted with facing point locks and lockbars, or some other device for the same purpose. These lockbars should be of a greater length than the space between any two pairs of wheels. It is the practice of one large railway to work their facing points, switch plunger and lockbar, from one lever in the box, but the usual practice is for one lever to work the points, and another to work the lockbar and plunger. A common form of bar is one carried on 4 or 5 rockers clipped to the side of the rail, the bar working to and fro in the direction in which the rails are laid. The switch plunger, or facing point lock, is a piece of steel which shoots into a slot in the stretcher rod between the facing point switches in one or other position, according to which way the switches lie. Such plungers and bars are worked by rodding from the signalbox. The final requirement in regard to points is that they must be worked by rods and not by wires.

Interlocking, dealing also with signalboxes requires levers by which points and signals are worked are to be interlocked and brought close together into a position most convenient for the person working them in a signalbox or properly constructed stage. The box should be commodious and have a clock and also block instrument for signalling trains on each line of rails. The point levers and signal levers to be so placed in the box that the signalman when working them shall have the best possible view of the railway, and the box itself to be so constructed and situated as to enable the signalman to see the arms and the lights of the signals and the working of the points.

The requirements in regard to interlocking are that a signalman shall be unable to lower a signal for the approach of a train until after he has set the points in the proper position for it to pass; that it shall not be possible for him to exhibit at the same moment any two signals that can lead to a collision between two trains; and that, after having lowered the signals to allow a train to pass, he shall not be able to move any points connected with, or leading to, the line on which the train is moving. Points also, if possible, to be so interlocked as to avoid the risk of a collision. Home and starting signals next in advance of trailing points, when lowered, to lock such points in either position, unless such locking will unduly interfere with the traffic. An exception to the locking of trailing points by home or starting signals might occur where such signal was some distance in advance of the points and where, consequently, a heavy freight train might be a long time in passing such signal, resulting in other movements in a shunting yard being held up. Distant signals must not be capable of being lowered unless the home and starting signals in advance of it (i. e., worked from the same signalbox) have been lowered.

Adequate means to be provided for the signalman to remind him of vehicles which are standing within his control. This may take the form of track circuit, electrical or mechanical fouling bars, &c.

Sidings, it is required by the Board of Trade, should be laid in so that shunting or switching operations over them shall cause the least possible obstruction to passenger lines. The exact meaning of this, of course, depends on local conditions. It does not mean that two short sidings with one connection to the running line and a capacity of, say, a dozen cars, must have a "shunting neck" when it may only be used for half an hour daily; on the other hand, where a switching engine is at work for a considerable period of the 24 hours, it would pay a railway company to provide sufficient accommodation to do its work wholly in the sidings, in order to leave the running lines clear for passing trains. Safety points must be provided upon Goods and Mineral lines and sidings at the junction with passenger lines, and to be so arranged that the points in the sidings are normally closed against the passenger lines and interlocked with the signals.

Junctions, siding connections and cross-over roads in a passenger station are so arranged as to prevent as far as possible, any necessity for standing trains on them, presumably to avoid the risk of such points being pulled between the wheels of the train and thereby giving an opportunity for derailment. The junctions of single lines to be, as a rule, formed as double line junctions.

The foregoing is a brief resumé, with comments, of the present Board of Trade requirements in regard to Signalling, &c. These requirements are issued at periods of a few years, but may be said to follow, rather than lead, the signalling practice of the railway companies. In special cases, safeguards, in addition to those specified by the Board of Trade, are considered necessary and are provided by the companies, and in other cases where the conditions are abnormal, the requirements are not carried out to the letter.

Automatic signalling schemes are in force at various places, as for instance, on the tube railways of London, and are inspected by the Board of Trade prior to opening, but as the equipment is specialized to fit the conditions, they are not considered sufficiently standard to warrant any Board of Trade requirement being issued.

Scientific Investigation Regarding the Priming and Surface Tension of Liquids

Pure science concerns itself not with application but with knowledge. If pure science has industrial applications it is in some sense accidental. Technical research, on the other hand, investigates industrial problems, and in its work may make substantial additions to pure knowledge. Eminent scientists, notably Lord Rayleigh investigated a children's plaything, the soap-bubble. He experimented with bubbles, and so did Prof. C. V. Boys, who lectured on the subject in the London Institution in 1890. Lord Rayleigh investigated their structure, coloring and durability; the search evolved new theories as to the surface tension of liquids. Pure knowledge is never without possible ulterior utility, however long the application may be delayed.

The view of the ebullition of water under pressure through a glass panel with an interior light, has quite an industrial application. It is interesting to watch the actual process of steam generation. Bubbles of small size rise through the heated fluid, coalesce into larger, join into froth and presently subside, having discharged their vaporous contents. In the case of sea water, for example, the frothy mass reminds one of washing day, and it is of considerable depth. The whole question of foaming or priming in a steam boiler is a question of bubbles, and the researches of scientists have a direct bearing upon the subject. It is almost wholly a matter of fluid skin or surface tension. There is a distinct suspicion that alkalinity in the presence of grease—which, latter, being lighter than water, is at the surface—generally leads to saponification, increased surface tension, and foaming or priming. Yet, on the other hand, small doses of oil have been known to stop the undesirable conditions. Investigation does not seem yet to have been made taking the soap bubble precedent as to the saponified condition of the water

The use of the surface blow-off is not practised as it might be, and the scumming of boilers is very desirable to effect changes at the point of steam liberation. The thermal loss due to this cause is more than counterbalanced by the drier steam produced, and the likelihood of lessened foaming. While the majority of boiler attendants are aware of the necessity of using the blow-down valve to discharge sludge and prevent undue concentration of the water, the value of scumming and the fittings therefore seem largely to be overlooked. Grease in a boiler is the least desirable of all contents; it has a remarkable resistance to heat penetration when present as a thin film on heating surfaces; and is very much worse than scale in this connection.

The chemistry of feed-water and feed-water rectification are large subjects, but every engineer should know the constitution of the feed-water employed, and a periodic analysis is a simple measure of precaution. Knowing this, together with the internal condition of the boiler, will in most cases allow some sort of treatment to obviate the worst consequences of any undesirable ingredients. Short of distillation there is no such thing as pure water, and absolutely pure water is not necessarily desirable, and as steam generation means the concentration of boiler water, it is essential to do something to remedy what otherwise may become dangerous, or at least not conducive to the effective life of the boiler itself. External rectification of feed-water is now a rather important engineering specialist field, and the locomotive fraternity now employ some apparatus to secure the obvious benefits resulting from good feed-water purification.

Rushton Reverse Gear.

The Rushton reverse gear is a power-operated piece of mechanism, frequently used on engines built by the Baldwin Locomotive Works, of Philadelphia, Pa. It consists of a rotary air engine, which is mounted on a suitable frame secured to the boiler. The motor drives through gearing, a horizontal shaft having a threaded section. On this section is mounted a nut, to which the reach rod is attached. The nut is made in halves, and these are held together by two horizontal bolts. A certain amount of clearance is allowed between the halves of the nut, and by removing thin liners placed on either side, and tightening up the bolts, the two sections can be drawn together to compensate for wear. The nut slides on a horizontal guide, so that the shaft is relieved of bending stresses.

The shaft carries a threaded section at its rear end, and this threaded section engages with a toothed sector. To the sector is attached a pointer, so as to indicate the point of cut-off. Admission of air and the direction in which the motor rotates, are controlled by an operating handle conveniently placed with reference to the engineman. When the gear has been shifted the desired amount, the handle is brought back to central position, thus stopping the motor. A hand lever is provided for use in cases of emergency. The entire device is very compact and simple to operate. It is handled by the Franklin Railway Supply Company, Inc., of New York. The device resembles the English screw reverse gear, and is always positive in its action.

Meeting of the Western Railway Club.

At the Western Railway Club which held its regular monthly meeting, Mr. George Austen, general inspector of boilers on the A. T. & S. F. read a paper on "Locomotive Firebox Maintenance and Repairs." The use of electric and oxy-acetylene equipments was strongly recommended.

Locomotives for the French State Railways

Forty consolidation type locomotives for Chemins de Fer du Midi, and 100 Consolidations of the same design, but with a different diameter of driving wheel (and other minor changes) for the French State have recently been completed by the American Locomotive Company. These engines are of basic American design modified in fittings and fixtures to suit French practice. They were designed by the American Locomotive Company, and each drawing was approved by a representative of the railway company and the State Department of France. All dimensions are in the metric system; International system of screw threads are used, however, and the French-Westinghouse system of pipe-threads, which the workmen used direct.

The boiler in general follows American practice, a good grate area being obtained by the use of a short wide firebox. Handholes are used instead of washout plugs to give greater accessibility for washing out. A dump grate in the front of the firebox is operated from the cab by a screw; the fire door opens inside, as required by a French law, and the outside end of the blow-off cock has a special thread for connection to the fire hydrants of the City of Paris.

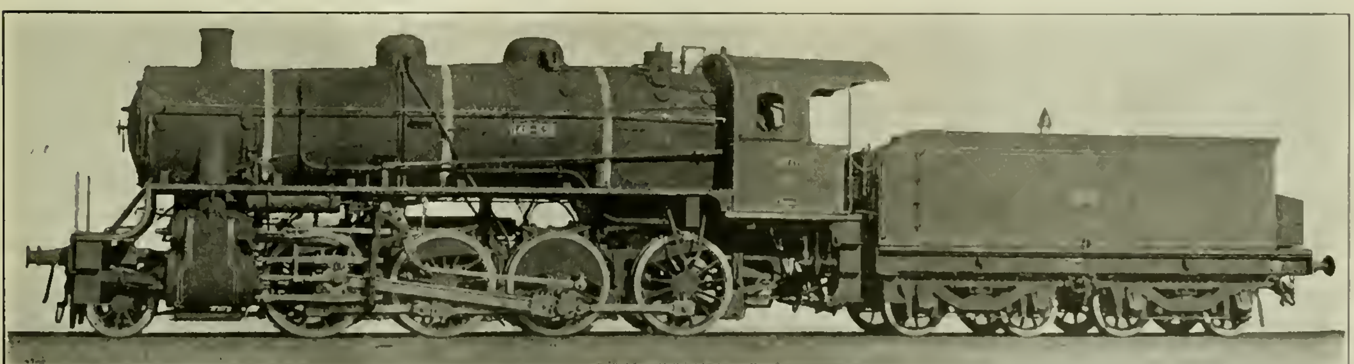
This is a precautionary measure of the highest importance for the protection of the capital city of France, which contains so much that is in itself beautiful, and of so great historic value. Much that is beautiful and artistic in France has been destroyed by the insensate, coarse and barbarous Hun, that what is left deserves the enlightened foresight for its protection. In the event of a general conflagration every locomotive within the bounds of Paris could be turned into an impromptu fire engine, and more engines could be brought in from the outside, if need be. The Napoleonic aphorism that "Paris is France" seems to have lost nothing from the days when it was uttered.

In order to quickly free the smokebox of smoke, the blower is made as a quick operating valve worked from both sides of the cab. Lagging on the boiler is omitted; the jacket being supported on a crinoline frame, leaving an air space, which acts as a non-conductor. Confined air is a very good insulator of heat, and is used with excellent results. A pneumatic sander is combined with a screw conveyor, which extends through the sandbox, and is operated from the cab. All these engines have a variable exhaust operated from the cab by a screw which passes through the handrail.

Some other interesting features are the left hand drive, screw reverse, cross-balanced driving wheels, muffled cylinder cocks, French Westinghouse brakes, French standard buffers and couplers, spark arrester, Roy buffers between engine and tender, by-pass valve operated by an air cylinder, firebrick arch and superheater, and also the water brake, which is used, as a general thing, in descending long, hard grades. The water brake consists of an arrangement for letting a little hot boiler water into the cylinders, and this is at once vaporized, and the engine being, of course, reversed, the slight pressure of this steam thus produced, acts with a retarding effect upon wheels, but the pressure is not sufficient to rotate them against the motion of the engine going down grade. The whole thing acts as a retarder and checks any undue increase of speed.

Dimensions and details of 8-8-0 for the Chemin de Fer du Midi: Track gauge, 1440 mm. or 4 ft. 8½ in.; fuel, bituminous coal; cylinder, type piston valve, diameter 23 stroke, 26 in.; tractive power, simple 35,100 lbs.; factor of adhesion, 4 ft.; wheel base driving, 16 ft. 9 in., rigid 16 ft. 9 in., total 24 ft. 11¼ in.; wheel base total, engine and tender, 53 ft. 3¼ in.; weight in working order, 159,500 lbs., on drivers, 138,500 lbs.; estimated weight on engine truck, 21,000 lbs.; estimated weight, engine and tender, 264,500 lbs.; boiler, type extension wagon top, O. D. first ring 64⅝ in.; boiler working pressure, 170.6 lbs.; firebox, type wide length, 96⅛ in., width 51¼ in.; firebox, thickness of crown, ⅜ in., tube ½ in., sides ⅜ in., back ⅜ in.; firebox, water space front, 4 in., sides 3¼ in., back 3½ in.; firebox, depth (top of grate to center of lowest tube), 27 5/16 in.; crown staying, 15/16 in. radial; tubes, material, hot rolled seamless steel, number 166, diameter 2 in.; flues, material, cold drawn seamless steel, number 26, 5⅜ in.; thickness tubes No. 12, flues No. 9; tube, length, 15 ft., spacing 11/16; heating surface, tubes and flues 1,840 sq. ft.; heating surface, firebox, 142 sq. ft.; heating surface, total, 1,982 sq. ft.; superheater surface, 456 sq. ft.; grate area, 34.2 sq. ft. Wheels—driver, diameter outside tire, 1,400 mm., center diameter 1,260 mm.; wheels, drivers, material, main cast steel, others, cast steel; wheels, engine truck, diameter, 850 mm., kind, cast steel; wheels, tender truck, diameter 960 mm., kind, cast steel, S. T. Axles—drivers, journals, main, 228 mm. by 250 mm., others 210 mm. by 250 mm.; engine truck journals, 145 mm. by 260 mm.; tender truck journals, 130 mm. by 240 mm. Boxes—Driving, main cast steel; others, cast steel. Brake—Driver, American, truck none; trailers none; tender, Westinghouse; air signal, French State Railway standard; pump, two-stage fives; reservoir, Lillie, 1-28½ in. by 78 in. Engine truck, swing center. Exhaust pipe, single; nozzles, variable. Grate, style, rocking. Piston, rod, diameter, 3¾ in.; piston packing, snap rings. Smoke stack, diameter, 14 in.; top above rail, 13 ft. 10½ in. Tender frame, Channel. Tank—Style, water bottom; capacity, 4,756 gallons; capacity fuel, 5 metric tons. Valves, type, 260 mm.; piston travel, 155 mm.; steam lap, 26 mm.; setting, lead, 6 mm.

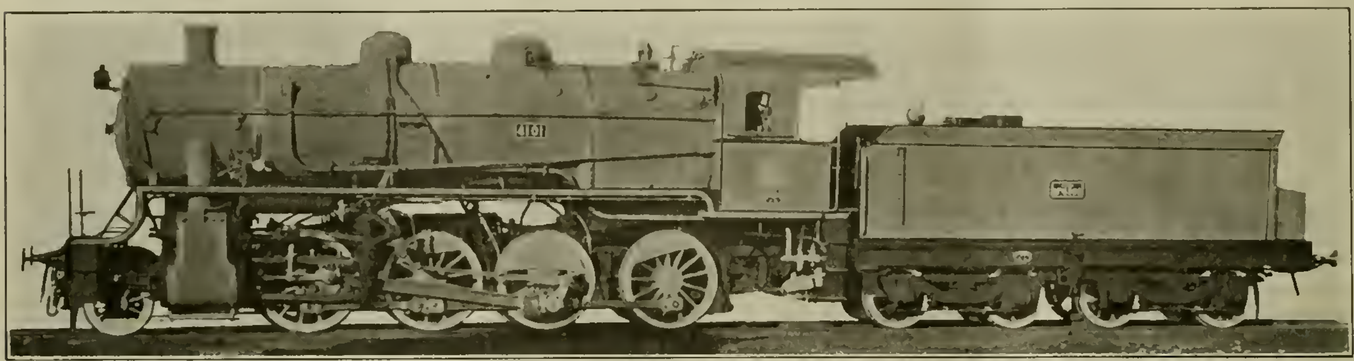
Dimensions and details for 2-8-0 engines for the State Department of France: Track gauge, 1,440 mm., or 4 ft. 8½ in.; fuel, bituminous coal; cylinder, type, piston vl.; diameter 23 in., stroke 26 in. Tractive power, simple, 35,100; compound—Factor of adhesion, simple, 3.97; com-



CONSOLIDATION FOR THE FRENCH STATE RAILWAYS BUILT BY THE AMERICAN LOCOMOTIVE COMPANY.

pound—Wheel base, driving, 16 ft. 9 in.; rigid, 16 ft. 9 in.; total, 24 ft. 11¼ in. Wheel base, total, engine and tender, 53 ft. 3¼ in. Weight in working order, 160,000; on drivers, 139,200; on engine truck 21,000; weight engine and tender, 266,400. Boiler, type, extension wagon top; O. D. first ring, 64⅝ in.; working pressure, 170.6. Firebox, type, wide, length 96⅛ in., width 51¼ in.; thickness of crown ⅜ in.; tube, ½ in.; sides, ⅜ in.; back, ⅜ in.; water space, front, 4 in.; sides, 3½ in.; back, 3½ in.; depth (top of grade to center of lowest tube), 27 5/16 in. Crown staying, 15/16 in., Radial. Tubes, material, hot rolled seamless steel, number 166, diameter 2 in. Flues, material, cold drawn seamless steel, number 26, diameter 5⅜ in.; thickness tubes, No. 12; flues, No. 9; tube, length, 15 ft.; spacing, 11/16 in. Heating surface, tubes and flues, 1,840 sq. ft.; firebox, 142 sq. ft.; total, 1,982 sq. ft.; superheater surface, 456 sq. ft.; grate area, 34.2 sq. ft.

Wheels—Driver, diameter outside tire, 1,440 mm. or 56.7 in.; center diameter, 1,300 mm.; driver, material, main, cast steel; others, cast steel; engine truck, diameter, 850 mm.; kind, C. S. S. T.; tender truck, diameter, 960 mm.; kind, C. S. S. T. Axles, driver, journals, main, 228 mm., or 9 in., by 250 mm. or 10 in.; other, 210 mm. or 8 in. by 250 mm. or 10 in.; engine truck journals, 145 mm. or 5½ in. by 260 mm. or 10 in.; tender truck journals, 130 mm. by 240 mm. Boxes, driving, main, cast steel; others, cast steel. Brake, driver, American; brake, tender, Westinghouse; air signal, Fives and Lillie, two stage reservoir, 1-28½ in. by 78 in. Engine truck, swing center; exhaust pipe, single; nozzles, variable; grate, style, rocking; piston, rod, diameter, 95 mm.; piston packing, snap rings; smoke stack, diameter, 14 in.; top above rail, 13 ft. 10½ in.; tender frame, channel. Tank—Style, water leg; capacity 4,756 gallons; capacity fuel, 5 metric tons. Valves, type, piston; travel, 155 mm.; steam lap, 26 mm.; ex lap clearance, 0 mm.; setting, lead, 6 mm. 1 mm.=0.03937 inch.



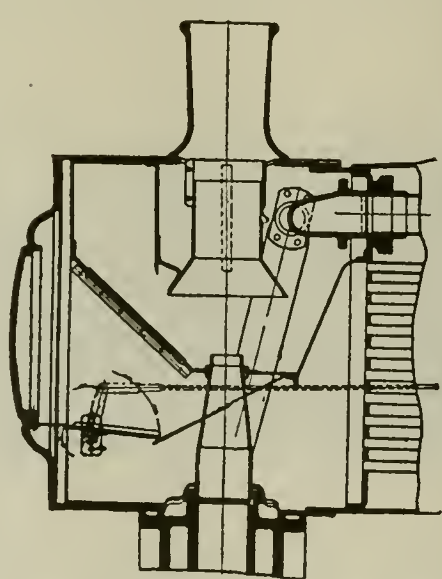
CONSOLIDATION BUILT BY THE AMERICAN LOCOMOTIVE COMPANY FOR THE CHEMIN DE FER DU MIDI.

Locomotive Spark Arresters and Petticoat Pipes

Fires caused by sparks from a locomotive are of much rarer occurence than formerly. The devices now in use have reduced the danger to a low point. Prof. Goss made extended experiments some years ago and among other interesting things discovered that on high winds sparks small enough will fly more than a hundred yards from the track and still retain some heat which might kindle some very inflammable substances. The heaviest sparks do not pass over thirty yards from the track, and this may safely be called the danger line, beyond which it is doubtful if any disaster directly traceable to sparks ever occurred.

It is conceded to be a physical impossibility to entirely avoid the danger, inasmuch as the production of sparks is one of the inevitable circumstances arising from the burning of any kind of wood or coal under any condition. With a forced draft such as is caused by the intermittent blasts from locomotive exhaust pipes, the spark producing causes are very great, and it will be noted that the greater the power that is used in propelling the locomotive, the greater the production of sparks.

Powdered coal and oil fuel on the contrary may be said to be free from sparks, and it would be interesting indeed to compare the amount of saving from this cause alone. The character of the fuel in any case is of much importance in spark producing, soft coal being much more prolific in that regard than the harder kinds of coal. Spark arresters in the very nature of things all have some deterring effect on the fuel consumption, and consequently on the generation of steam. The problem therefore has been one involving the highest degree of spark arresting quality while looking towards the heat retarding effect on combustion. The deflector sheet lends itself readily to the initial stoppage of much of the flying particles of unconsumed fuel that are carried through the flues by the sudden rush of air caused by the vacuum produced by each successive blast from the exhaust pipe. A particular event, in the general adoption of the brick arch, has been the more complete combustion of coal, and consequently the lessening to a minimum of unconsumed particles of coal.



SMOKE BOX WITH DRAFT REGULATING DAMPER IN CLOSED POSITION.

In the early locomotives the use of wire netting began in the smokestack and gradually came lower and lower, until it took the general form of a screen extending across the smoke-box near the center and below the exhaust nozzle. A semi-circular piece of netting completed the device. This was greatly improved upon by constructing the netting in the form of a hopper, being attached to the deflector sheet by pieces of angle iron, the extended sloping sides of the hopper shaped device not only presenting, a more ready angle of entrance for the escaping smoke and gases, but it also provides a much

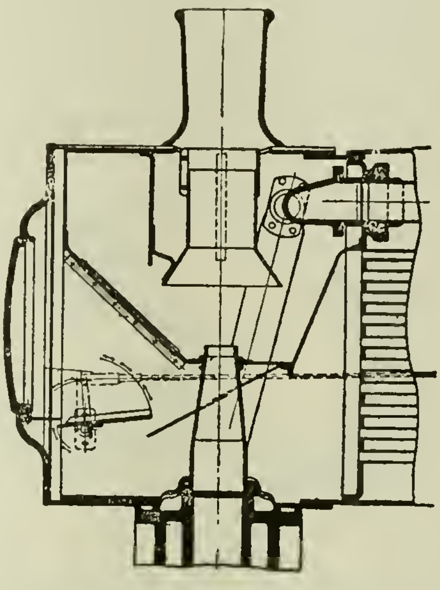
larger space for the same purpose. It is an important feature in the construction of smoke-box screens that the amount of opening in the netting should be larger than the area of the smokestack. A certain percentage of excess of area should be allowed, as some clogging of the openings either in netting or perforated metal is inevitable. The openings in netting or plates being generally more than half of the entire surface of the material, a comparison between the smokestack area and the area of the netting can readily be made.

In the case of fitting the netting or perforated metal around the steampipes it is of importance that the fitting should be exact and securely attached, as the heat to which the material is subjetced, with intermittent cooling, has the effect of warping and bulging the material in a very short time, with the result that openings and fractures not infrequently occur. The bést materials of which the spark arresters may be constructed soon lose their consistency and rapidly crystallize and decay. Patchwork, unless carefully made, creates new rents, and there is perhaps no part of the locomotive more liable to fracture or disturbance than the spark arrester.

It is to the credit of the railroads generally that the smoke-boxes of the locomotives are kept in good condition.

Probably the device in its present form is as near perfection as can be expected, but this does not prevent our inventors from experimenting with new appliances. We had recently the opportunity of examining contrivances that looked like windmills in the smokestack, one of them devised to whirl the sparks through an e tended pipe back to the firebox again. Another, with an enlarged smokestack, whirled the sparks into a large recess similar to the balloon stacks of the wood-burning days. The failure in both experiments was complete. The back pressure on the exhaust affecting the combustion to such an extent that it was found impossible to maintain the requisite steam pressure. The present appliance, if properly maintained, has a degree of efficiency that it would be difficult to surpass.

Reference might be made to what is known as the petticoat pipe, which in some form has for many years been a feature in American locomotive appliances, and is more or less of a necessity in view of the limited dimensions of the smoke stack on the modern locomotive. It serves in a great measure the same purpose as the tubes of an injector do in inducing the flow of water. The draught of air passing through the flues is led into the bell mouth of the petticoat pipe by the action of the exhaust, and it is essential that in the event of the petticoat pipe being separate from the smokestack, its size at the upper end should be proportionate to the size of the smokestack, and it should be set exactly central with the exhaust nozzle and smokestack. The effect of the petticoat pipe in regulating the draught in the smoke box is coincident with the deflector sheet, and both are intended to



SMOKEBOX WITH DRAFT REGULATING DAMPER PARTLY OPEN.

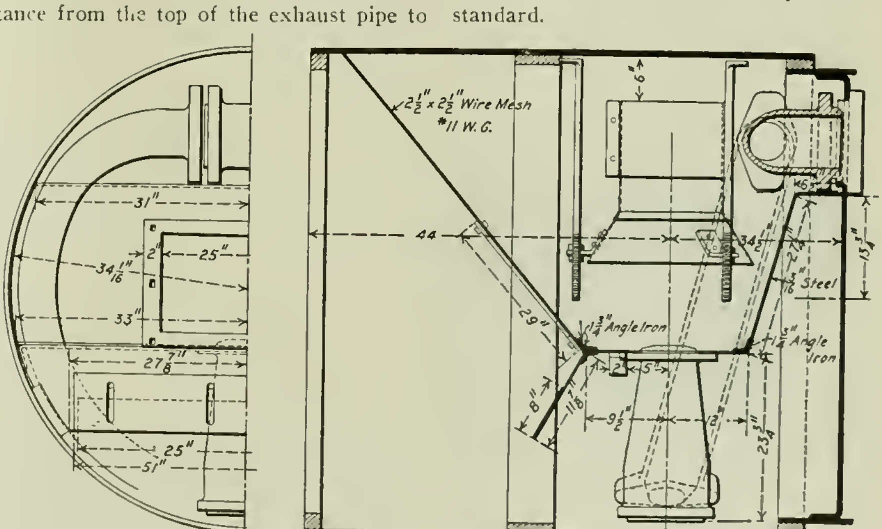
create a uniformity of draught through the flues, so that the heat should be equally distributed over the entire area occupied by the flues.

Exact rules cannot be laid down for the location of the petticoat pipe. The distance from the top of the exhaust pipe to the lower edge of the petticoat pipe is usually made about equal to the diameter of the smokestack. A slight change of the height of the pipe in regard to its location has often a considerable effect on the draught and consequently in the steaming qualities of the engine. The uniform appearance of the flues is the best test of the uniformity of draught. When the draught is strongest the flues are cleanest, and if flues are partially choked with soot or ashes it is conclusive proof that the draught has not been sufficiently strong in that locality to keep them clean.

Generally speaking, if the petticoat pipe is set too high, the draught will be strongest in the lower flues, and if the pipe is set too low the upper flues will receive the strongest amount of draught. In view of these facts very little experimenting should be necessary to obtain the best working height at which the petticoat pipe should be kept.

In the case of badly proportioned or badly set petticoat pipes the effect on the fire is of the most pernicious kind. In cases where the fire is burned rapidly in some parts of the firebox it is safe to assume that the cause of the trouble is in the petticoat pipe, and a slight change of position of the pipe will show some variation in the appearance in the degree of evenness with which the coal is being burned in the firebox, and the indications will readily lead to such changes as may effect a complete remedy.

The petticoat pipe has long been in service on American locomotives, but its use in European locomotives is comparatively recent. The tendency in American locomotive construction is to form the petticoat as an extension of the smokestack, a portion of which is so constructed as to lead downwards near the center of the smoke box, and it is safe to assume that this method will eventually become standard.



GENERAL ARRANGEMENT OF THE MASTER MECHANICS' ASSOCIATION SELF-CLEANING SMOKEBOX.

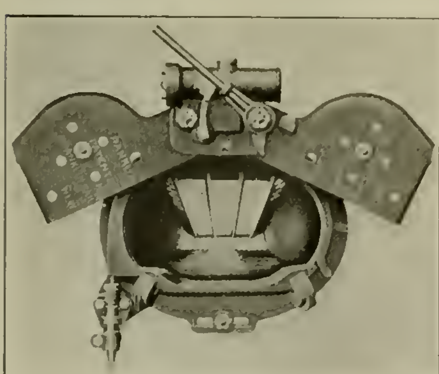
Meanwhile, as already stated, too much importance cannot be placed on the necessity of adjusting the petticoat pipe in exact alignment with the exhaust nozzle and smokestack. The height may be determined by experiment, its action by the appearance of the fire and condition of the flues, and it should be examined every day together with the netting.

Pneumatic Firedoors On Locomotives

Details of Construction—Economy In Operation

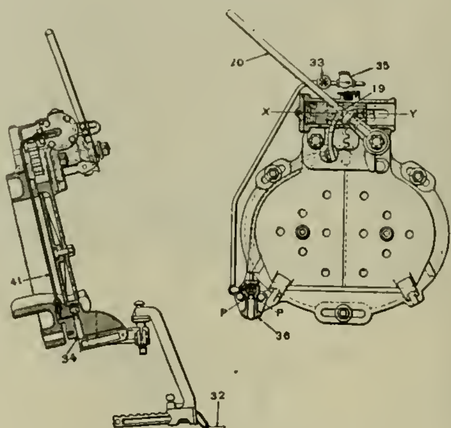
In these days when economy is the aim and safety the password, it is surely right and proper that a word should be said in favor of those special devices that combine the desirable qualities referred to, more especially if the cost of their application is paid for by the unquestionable saving accomplished in a very short time. Among these the use of the pneumatic firedoors has already become particularly prominent, and bids fair to become universally applied to the modern steam locomotive. On the heavier types of locomotives, not equipped with mechanical stokers, it has become a real necessity. Several very successful devices have already been perfected, and among these the Franklin Automatic Fire Door has already grown in marked popular favor, and a brief description of the details of this device will be of interest to all who may not be familiar with its construction.

It consists of a door frame, door plates, operating cylinder and pedal which controls the movement of the door. Taking what is known as the "Butterfly" door as being among the most common in use, the door plates are mounted on hardened pivots and work together through heavy gear teeth. One door plate is connected to the enclosed operating piston by a steel connecting link. The door is opened by a movement of the piston, the power being compressed air admitted to the cylinder on which the piston is enclosed. When the piston reaches the maximum travel the



BUTTERFLY FIRE DOOR.

door is fully open. Baffle plates are fitted to the door plates, and protect the door plates from the intense heat of the firebox. They also serve to heat the air that passes through the openings in the door plates. This not only aids combustion, but helps to maintain a more uniform fire-box temperature. It will be observed in the first illustration there is a hand lever, the purpose of which is for operating the doors in the roundhouse when there is no air pressure on the engine. When the door is operated by air pressure this lever does not move. In general service, as we have already stated, the door is operated by air pressure, the air being admitted through a strainer valve and an adjustable valve into the operating valve. When the foot of the operator is placed upon the tread, a valve is opened at the lower part of the door, being raised from its seat,



DETAILS OF FRANKLIN PNEUMATICALLY OPERATED FIRE DOOR.

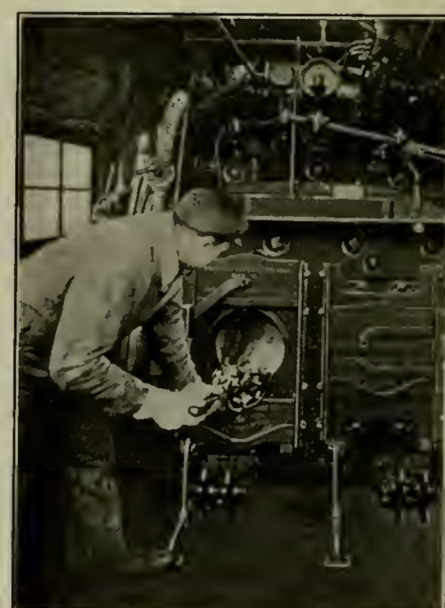
allowing the air pressure to pass through a pipe which connects the valve to the cylinder head. The enclosed piston is carried forward by the action of this air pressure, and transmits its movement to the doors through a link which is attached to the left hand door plate. The plates are connected by intermeshing gear teeth.

As the piston moves forward the door plates are rotated around the fulcrum pins until they have uncovered the opening in the door frame. In this position the link is centered, and it is impossible for the piston to travel any further. Should the momentum of the door plates be such as to carry the doors beyond the full opening position the piston would be pulled back against the air pressure in the cylinder. This would act as a cushion and bring the doors to a stop without any jar or noise.

When the foot of the operator is removed from tread the valve closes, cutting off air pressure to the cylinder, at the same time permitting the air in the cylinder to exhaust to the atmosphere through an exhaust put in the valve body. The weight of the doors causes them to close, at the same time returning the piston to the left end of the cylinder. In closing the door is cushioned, as the doors close rapidly there is sufficient pressure remaining in the cylinder, the exhaust being restricted, to slow up the movement of the doors and allow the plates to come together without slamming.

A latch having two notches to engage the hand lever is also provided. The first notch, which is known as the smoke notch, holds the door open about eight inches at the bottom to allow the admission of air to the fire-box, while the locomotive is standing at stations. The bottom notch is located so as to hold the doors in the full open position. The supply of air for operating the door should be taken from the main reservoir pressure. All doors are furnished complete with frame ready for application to the boiler, and may be readily attached during boiler washout periods, the job being usually done by two men in about three hours.

In operation, the door should be opened and closed after each scoop of coal by means of the pedal, and from carefully collected data there is an average of 585 distinct movements on the part of the fireman for each ton of coal consumed on locomotives not equipped with pneumatic fire doors. This number of movements is reduced to an average of 234 by the use of the door described. On some long freight runs, where twenty tons of coal may be consumed, the relief to the fireman is very great. The lessening of



INTERIOR OF LOCOMOTIVE CAB SHOWING FRANKLIN VERTICAL FIRE DOOR.

the labor of the fireman is not the only gain. The ready opening and closing of the door after each scoop excludes as much air as possible from the firebox, thus preventing the expansion and contraction of the tubes, keeping up the temperature of the firebox and insuring the air being drawn through the grates so as to furnish necessary air for combustion.

Extensive tests have also shown that in the amount of coal used on engines equipped and not equipped with the pneumatic fire doors the difference is con-

siderable, the lowest showing a gain of over 6 per cent, and in several tests as high as 12 per cent, the average being based on the number of miles run per ton of coal with the same class of locomotives, and showing 19.62 miles per ton with the Franklin fire door, and 17.45 miles per ton with hand-operated door, the nearest approach with the latter method being 18.29 miles per ton, as compared with 19.44 miles per ton when equipped with the pneumatic door.

The care of the door involves little labor. An oil cup is provided on the top of the cylinder, and the fulcrum pins are oiled through oil holes on the front of the cylinder. All other parts of the door should be operated without oil, the use of oil on the door plates being a detriment to their operation.

In conclusion, it may be noted that while we have confined our description to what is known as the "Butterfly" door, the device is used in a variety of forms, some with the doors opening vertically, one portion moving upward and the other downward. This type is especially serviceable in the case of boilers equipped with double doors, and where the limited space between the doors would preclude the movement of the doors used in the "Butterfly" type.

Apprentices on the Santa Fé.

Not long ago at a meeting of the Western Railway Club Mr. W. F. Thomas, supervisor of apprentices on the Atchison Topeka & Santa Fé outlined the system of training young men for mechanical work, on that system. He referred to the equipment, to the shop instructors and to the method of selecting apprentices; a system in which letters of recommendation were not required nor were they deemed of much value. Continuing he said, in part:

We have in our shops, a body known as the apprentice board. This board is composed of the general foreman, department and gang foremen, the shop instructors and the school instructor. Each apprentice either in person or in name, is brought before this board every six months during his apprenticeship of four years. All matters relating to the talent or fitness of the boy are looked into and handled in a recommendatory manner and the result is sent to the ranking mechanical officer of that shop for his action, and finally to the supervisor of apprentices. This plan makes an officer take an active interest in the boy. He is called upon to pass judgment upon the boy, and he soon feels and knows he must find out about the boy. It has also created an interest in the other shop employes, and desire upon the part of each foreman to treat all men with that interest and feeling which begets loyalty and service.

We furnish to each master mechanic one, to the superintendents of shops two or three, graduates of engineering or technical colleges. These are known as special apprentices. They are selected solely upon a personal interview. We place no credence or faith in letters of reference. Experience with these college men has been of doubtful success. So few remain long enough to prove their worth. There is no doubt of their ability —but serious doubt of their adaptability or application. They are apparently unwilling to start at or near the bottom and work up. They must, however, in railroad work, acquire the practical knowledge. One cannot afford to put a man in authority who does not know his business.

The Santa Fé selects about a dozen of the best and brightest of the graduates of its apprentice system and sends them to the best contract shops in the country, to acquire new ideas in handling men and material. Some previously sent, went to the Baldwin works. The Baldwin people gave these young men an opportunity such as has never been enjoyed by any before.

The Santa Fé Railway's apprentice system has been in vogue nine years. From 345 boys in 1907, the number has grown to 1,023 today. Starting out with machinist apprentices only, it has expanded till now we are giving instruction to boys in eleven trades. Over 120 boys have been promoted to some position of responsibility on the road. The Topeka Shops, the largest shops on the system, have not employed a skilled mechanic from the outside for over two and a half years. It is some comfort to the master mechanic or superintendent of shops, to know when going about his duties that he has not to keep on his mind the worry whether he will have enough men for his shops. In habits and character these young mechanics are made out of good stuff. Their homes are there, their friends and companions are there. They are more than first class shop men; they are good citizens.

Reducing Fire Losses on the P. R. R.

Promptness on the part of employes of the Pennsylvania Railroad in extinguishing fires, before the arrival of the public fire companies in the year 1917, saved $10,445,196 worth of the company's property from destruction. Altogether 334 fires were put out by employes. These occurred on property very highly valued, but the total loss was only about $12. The total fire loss of the Pennsylvania Railroad in 1917, including those cases in which public fire companies responded, was $306,465.

Last year's fire record of the P. R. R. clearly illustrates the value of training employes in fire fighting methods, and of organizing fire brigades, and of providing extinguishing apparatus at various points. The regularly organized fire brigades extinguished altogether 66 fires. The entire loss sustained was $3,867, or less than $59 per fire. Chemical extinguishers checked 30 blazes. Fire pails were used 53 times to extinquish fires. Locomotive fire apparatus was used in 19 fires in which the combined loss was $1,176, the property threatened being valued at $332,420. Water casks and fire pails extinguished 23 fires with a total loss of $800. Fire hose was used 18 times. The high pressure fire lines put out eight fires at a loss of $108. Chemical engines proved their value in four fires by keeping down the total loss to $630. Sand pails, extinguishers and tug boats were utilized in putting out other fires. The employes of the railroad, without apparatus, extinguished 107 fires.

Fifty-one fires occurring on the property of the Pennsylvania Railroad, last year, were due to causes beyond the control of the employes. Adjacent property burning caused 25 fires; adjacent rubbish caused two; boys playing about were responsible for two; incendiaries for three; lightning for three; tramps for three; a tornado for one, and spontaneous ignition for 13. The largest number of fires, except those from adjacent buildings, are due to this hitherto unexplained cause. The majority of spontaneous combustion fires result from the collection of inflammable rubbish with a sufficient dampening of oil or such-like substance, the rubbish heap being somewhat protected and in a position to retain what heat may be deloped, until the igniting temperature is reached, when flame bursts forth and this may not be discovered until it has gained headway.

Substitute for Sheet Steel

It is reported that in England a substitute for sheet steel for various purposes has been found in the form of an asbestos-cement composition. Ground asbestos mixed in the proportion of one to six with Portland cement and worked into a paste with water is the fundamental in this substitution. A machine something like those used in the making of paper forms this material into sheets, which are trimmed to size and, if desired, corrugated for roofing purposes. After seasoning the material is ready for use. It is durable, resistant to climatic conditions and also to any acids in the atmosphere; it is fireproof, and also a non-conductor of heat.

Crossing the Bosphorus.

It is reported that work will be begun next month on a bridge and tunnel across the Bosphorus uniting Europe and Asia. The narrowest point is about 1,800 feet. The contract has been awarded to a Budapest firm by the Turkish government.

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A Chance for Action.

One of the best opportunities that has ever presented itself in the railroad world is in sight and the Government should take advantage of it in the public interest. The function of a Government is not always to restrain or rule, right and proper as these things are. It may at times, it seems to us, be that enlightened leadership, is one of the strong roles it can play with advantage. In the matter of compulsory safety, the field is open to it as it is to no other agency.

One does not feel insulted, nor is there any implied reflection on a man's honor when the cash register hands out a bill, added up without flaw, or a full receipt for only the exact amount paid. This mechanical rectitude and machine-made honesty, is looked on as commendable rather than the reverse. We have before now spoken of the "Dead Man's Handle," where death or a sudden faint of the motorman, enforces the safety of the traveler, by the stoppage of the train.

The "No-Voltage Control" in the machine shop (more fully explained on page 93 of this issue), makes for mechanical safety of the operative. In case the current by which the machine is driven, fails or is cut off for some reason, from outside while the machine controller is on, intelligent thought must be used to do further work. The machine cannot be started again when the current goes on again, unless the operator return the machine controller to zero and moves it up point by point as the machine is desired to gain power and speed. In this way the inadvertant working about or tinkering with, a stopped machine by the operator, perhaps tired of waiting for current, is avoided. The machine can only be re-started by the intentional purposive action of the man in charge. His forgetfulness of cause of the stoppage cannot jeopardize his life or limb. Safety is his, without the asking and perhaps his knowledge.

Recently a proposal was made by an assemblyman that all telephones should be supplied with an automatic electrically-operated counter, so that a subscriber, at the end of a given period, should be guaranteed the statement of the number of calls and the price of each, for the given time, so that like the cash register, he need not be compelled to take the word of an interested or careless or inaccurate employee. The need for such things is apparent when it is remembered that army surgeons and experts, so it is stated, after examination, found 2 per cent of drafted men were mentally defective or in some way incompetent.

All these things; the cash register, the dead man's handle, the no-voltage control, the telephone recorder, and the mental test of soldiers, have for their object the elimination of the "human element," and the plain, straightforward reason for this is that the human element has been demonstrated to be unreliable, and it has conclusively proved to be so, in the variety of ways, as exemplified in the few devices and methods we have mentioned. Our readers can supply other examples and we would be glad to have them do so.

Now, if this fallibility of the "human equation" exists, and as this danger owing to mental makeup of various men is there, beyond question, is it not time that the stop signal be also included as one of the most necessary and effective safety appliances?

Human fallibility on a railway is no different from what it is in other instances, but its consequences may be the most serious in the world. On page 37 of our February, 1918, issue, we gave some explanation of an exceedingly inexpensive and effective stop signal, where the breaking of a glass globe, no more costly than an electric bulb, struck by a bar of iron, held in the stop position and co-acting with the semaphore blade, does the business. On page 40 of the same issue, we called attention to a new and effective method of telephoning a moving train, the system is being tested by the Canadian Government. It is a magnificent safety scheme.

We have shown the existence of mental failure; we have shown how, in other walks of life, the serious endeavor is to remove the menace of forgetfulness, distraction, thoughts wandering from the business in hand, and other forms of mental failure; we have given two tested methods of eliminating the "human element" on railroads—the stop signal, and the speech with a moving train—and we believe that as the rialroads have, so far, not fully acted on the cogent evidence at their command, it is time for the Government to take some effective steps to get results, and not permit a vitally important subject to be smothered in reports, monographs or minutes. The British Board of Trade have done it properly, why not the United States as well?

Service.

It may very reasonably be asked, what does a railway supply man mean when he speaks about "Service"? Briefly, it means looking after the performance of the things he has sold. It is said that recently a railroad man called a prominent supply firm on the long distance telephone asking for a repair part for a fire door that had been accidentally broken. The supply firm sent a representative to a neighboring railroad, and borrowed the part wanted, and then forwarded it on a fast train by one of its own employes. Only for this quick action, an engine on the railway asking for help would have been out of service for several days. As a matter of fact, it lost not a minute. This is real service.

In a poem by Rudyard Kipling called "Kitchener's School," written after the British had prevented the Sudanese, in 1898, from constantly menacing Egypt, the poem supposed to be by a Mohamedan, speaking of the English, says:

"Till these make come and go great boats or engines upon the rail—— But always the English watch near by to prop them when they fail." Now, this watching near by and this ability to prop, exemplify what we call service.

Another feature which stands out very prominently in dealing with a reputable supply house is that they do not want any one to buy an appliance in the dark. They are as eager for the searching road test as the railway man. They feel that the sale of goods does not end the transaction, but that the good-will and the satisfaction of a customer is not only very well worth while, but it is an essential.

In old days, the "gentleman" looked down upon trade, and upon those who made their living by trade. We are inclined to regard this attitude as unworthy and snobbish. The gentleman never admitted the social equality of the man who "soiled his hands" with trade. This may be untrue, and it may have been unworthy, but it had its origin in the practice of the tradesman of that day. His idea was

to sell goods, if need be, by misrepresentation, trickery, dishonesty and extortion. He resorted to any kind of scheme simply to sell his wares, and the subsequent discovery of fraud by his customer was nothing to him. He offered no satisfaction and gave no redress. In time the practices of the "trade" were regarded as due to the objectionable character of the men in trade. In the days when the gentleman placed chivalry and scrupulous honesty in the category of the highest virtues of squire and knight, the feelings toward trade were then almost completely justified.

Today the idea of service, which takes close cognizance of good will, honesty, and the making good of statements about devices, and looks for the pleased return of customers, has revolutionized the old-fashioned conception of the man who sells. It was from the double-dealing of the seller, that the expression, "Let the purchaser beware," crept into the Latinized legal formula of a maxim. Service, as we know it, has swept all this away.

A railway device is put upon the market, sometimes it is advertised, but what is bound up with the article, and what is sold with it, is service. That is not always so stated, but it is implied, it "goes without saying." Those who are accustomed to dealing with our supply firms have no doubt noticed the ready and eager acceptance of an offer of test an appliance made by or sold to a railway company, and no question can be asked that the supply firm will not answer or make arrangements to find the answer to no matter what trouble and expense may be involved. The old days of buy "on sight, unseen," where investigation was precluded and where probable performance was unknown, are now rapidly giving way to the safe and sane method, where applied science leads the way onward in the light, and where the old-time groping and stumbling in the dark for the sake of some one's unworthy gain, have given way to straightforward statement of efficient performance backed by careful trial, and where honesty, fair-dealing and generous treatment have placed the hallmark of sterling goods on the products and specialties offered for sale in the railway world today.

The General Service Car.

The activities of the railways' war board have moved in the right direction. One of their accomplishments has been "to arrange for the movement of coal for naval use from mines in West Virginia to the Pacific Coast in box cars instead of in open cars, in order to prevent the uneconomical empty haul of open cars from the Pacific Coast point to the East." They have with keenness of perception seen the advantage of making the best possible use of what cars we already have.

Our problem is very largely one of utilization of the individual car. A slightly different construction of these box cars which are to be shipped west with coal, would help to relieve the situation. What we have in mind is that when these cars reach the Pacific Coast, loaded with coal, they must be unloaded by hand at a time when we need cars in active service, and also at a time when we need men for the war.

From a utility standpoint it seems not only fitting but imperative that we should speak again of the possibilities of the general service car. Many of these cars are already in use by the railroads and are carrying freight in both directions, for which they are well fitted.

Referring again to the war board's action, it illustrates the fact that while a coal mining region is not very often a manufacturing center, yet from the coal mines the coal must go to the manufacturing centers, and from the manufacturing centers the articles which they have manufactured must travel. This is also true of products from the farm. As in the case referred to, the car must in many instances (in bringing the coal from the mines), travel a long distance and over the same road on its return, and if it is not adapted for its return lading, it means an empty haul. This in turn means locomotive power wasted, time and money lost on train crews and operation, the car out of service, with the loss of earning power. While these things are all important, the most important thing is the fact that cars are needed and needed badly. From the construction of the general service car it can come into a situation of this kind, and make possible the use of the coal car on its way from the mine with coal, and on its return trip it can be utilized to bring back that which could be used in or near the mining section. It is at once apparent that without attempting to interfere with or change the movement of freight, we may by the use of the general service car, adapt our railroad vehicles so that they can be used coming and going.

If we are to build more cars, they should be so constructed that they can carry any kind of freight, or dump any kind of load; so that they may be kept constantly in service. By the application of the general service car idea, to the gondola, such a car can be used for lumber, steel billets, rails, etc. At the same time such a car is suitable for coal, because it can be dumped. With the box or stock car, to which the general service car idea is applied, a railway not only has a box or stock car suitable for stock or classes of freight that need ordinary protection, but it also has a car suitable for coal or material that may be dumped.

What is accomplished in the general service car is the continued usefulness of any car for the work which it has always performed, and in addition a railway has practically acquired a car suitable not only of carrying any material capable of being dumped, but so constructed that such material can be quickly dumped. It is no idle theory to say that the general service car can do the work of two. The work performed by cars of the general service type can be done with economy.

Fuel Saving.

The coal situation in war time was the subject of a paper read before the Canadian Railway Club, Montreal, last January, by Mr. T. Britt, general fuel agent of the Canadian Pacific Railway. In alluding to the coal shortage, Mr. Britt said that the United States Government has been very considerate toward Canada, and will continue to be so, the intention being to treat Canada on an equality with any State in the Union, but, while doing this, they expect and insist that we do the same as they are doing, viz., inaugurate a campaign for the intensive conservation of fuel.

Canadian railways have already reduced their annual passenger train mileage by 10,000,000 miles, and have further decreased the fuel consumption by lengthening out the times of other trains and by eliminating fast freights and instead running trains with full tonnage, and by equipping locomotives with superheaters and the best known modern means of lessening fuel consumption. The Canadian Pacific Railway has been helping the cause by breaking up and using old ties for fuel —this even at considerable expense of labor, train service, etc., gathering and handling.

Referring to the waste of fuel, Mr. Britt claimed that there is a lot of fuel wasted by automatic stokers not receiving intelligent attention from the fireman. The stoker itself when in proper working order will do all that is required of it, but there are, however, occasions when it will not do what it is supposed to, and it is then that a properly instructed fireman will give necessary assistance with a consequent saving in fuel.

The majority of our passenger trains, particularly the sleeping cars, are overheated—it being left largely to the discretion of the colored porter as to what is considered a comfortable temperature. The result is that the temperature is kept up to a point that means comfort for the porter and discomfort for the passengers.

As a matter of fact, the one practical and needful thing today is to save coal in order that our transportation lines and munition plants may have sufficient to carry on. It may be patriotic and a certain amount of pleasure may be derived from singing "Keep the Home Fires Burning," but the saving of one ton of coal is of more practical benefit toward assisting the boys in the trenches than the singing of 100 songs.

Air Brake Department

The Brake Leverage System; and the Clasp Brake—An Air Brake Lift Gauge—Questions and Answers

GENERAL RATIOS—LOSSES IN TRACTIVE POWER DUE TO DRAGGING SHOES—CLASP BRAKE FIRST USED IN GREAT BRITAIN AND IN EUROPE—EFFICIENCY GAINED WHEN USED IN THE UNITED STATES.

Discoursing on Recent Developments in Brake Engineering Principles and Practice, Mr. W. S. Dudley said in effect, to the New York Railroad Club at a recent meeting that until the Lake Shore tests of 1909, the generally accepted maximum multiplication (total leverage ratio) was 9 to 1. When the car weight exceeded the ability of one size brake cylinder to provide the desired braking ratio with 9 to 1 total leverage ratio, the next larger size brake cylinder was used, which permitted a correspondingly lower total leverage ratio to be employed. Experience has shown that, average conditions being considered, the use of a higher total leverage ratio than 9 to 1 would so magnify the effects of shoe wear, horizontal travel of shoe, and lost motion and deflection in the brake rigging, that the piston travel could not be maintained at the desirable 8 ins. for full service applications without destroying the shoe clearance necessary to avoid the many evils of dragging brake shoes and "stuck" brakes when the brakes were supposed to be released.

One of the most interesting and instructive, if not the most important results of the Lake Shore tests was the determination, from dynamometer car records, of the loss in tractive effort due to the brake shoes rubbing the wheels. With the brake rigging adjusted to 6 ins. instead of 7 ins. piston travel with a standing emergency application, an increase of 35 per cent in tractive effort was found to be required to haul the train at 60 miles per hour, this being the average observed over one mile of track. The report points out that on trains with heavy cars equipped with six wheel trucks and a 9 to 1 and greater leverage ratio, this loss was going on, day after day on all heavy, fast passenger trains and strongly urges the advantages in hauling capacity of locomotives and saving of fuel, to be realized from a lower total leverage ratio and consequently greater shoe clearance.

The design of the modern six wheel truck is such that the single brake shoe must be hung low on the wheel. The forces on the single brake shoes are consequently in such directions as to develop a considerable downward pull on the brake beam hangers, irrespective of the direction of motion of trucks, sufficient, at least, to finally hold the shoe down to its lowest position, whether reached by the direct pull of the hangers or the momentary compression of the equalizer springs, due to motion of the car body. The forces thus developed especially on six-wheel truck cars are sufficient to compress the equalizer springs practically solid so that on releasing after the stop, the upward movement of the pedestals, with respect to the journal boxes, is from ½ to 1¼ ins. The effect of this is, of course, to lower the position of the shoe on the wheel during the stop, and the horizontal movement of the shoes multiplied by the leverage, together with whatever lost motion exists, produces the excessive increase in running over standing emergency piston travel which has been observed in all tests made under these conditions.

This is a source of direct loss in brake cylinder pressure, both in amount obtained for a given reduction and in time to obtain it. It is evident that if the total leverage ratio could be reduced, the evil effects of this action could be correspondingly lessened. In general, the amount of reduction possible depends on the car and rigging arrangement For the type of six-wheel truck with one shoe per wheel used in the Lake Shore tests, it appeared that a total leverage ratio exceeding 6 to 1 would involve material losses in efficiency as a result of the excessive increase of running over standing piston travel adjustment when slack adjusters were not used, or of running emergency over running service piston travel when automatic slack adjusters were used. Realizing the importance of the shoe location in this connection, the committee presented a sliding scale recommendation of 6 to 1, 7 to 1 or 8 to 1 maximum permissible total leverage ratio according to whether the shoe centers were 5 ins. or more, 2 ins. to 5 ins., or 9 to 2 ins. below the wheel centers.

This was a temporary move in the right direction to produce immediate betterment. But after a study of the reasons for the losses experienced the crux of the problem lay in the location of the shoes and the disposition of the forces applied to them. When existing evils in these directions were eliminated, a total leverage ratio of 9 to 1, or even higher, was shown to be feasible.

No part of the brake apparatus has suffered more from neglect in design, installation and maintenance than the rigging connecting the brake cylinder to the brake shoes. When installing the brake rigging on new cars, the possibility of levers or rods fouling, in passing from one extreme of all new shoes and wheels, new rigging and slack adjuster "in" to the other extreme of worn shoes and wheels, worn rigging joints and slack adjuster "out," is often overlooked. But while there is room for betterment in the elimination of defective installation features, it is now generally recognized that with the weights of modern passenger equipment cars and the brake forces they require, the single shoe type of brake is unsatisfactory to the point of being decidedly detrimental.

A recognition of the possible losses in these directions appears to have influenced the design and application of the brake rigging in Great Britain and on the continent, from the first, along the very lines that seem to have been persistently avoided in this country. There the use of two brake shoes per wheel is the rule, and during the last few years we have witnessed in the United States a growing interest in the advantages of the clasp type of brake rigging.

Messrs. T. L. Burton and H. A. Wahlert have summarized the advantages of the clasp brake somewhat as follows: It has been demonstrated by train brake tests that with an emergency brake application, a much shorter stop can be made with the clasp brake than with the single shoe brake, other conditions being the same. If properly designed, manufactured and installed, there is no occasion to disconnect any part of the clasp brake rigging between shopping of cars. A thin brake shoe, or loss of a brake shoe does not in all cases necessitate cutting out a brake to save the brake beam. If the clasp brake is properly designed, manufactured and applied to the car it will be practically impossible to adjust the rigging so as to impair its efficiency or interfere in any way with its proper operation.

The axles and truck frames in addition to performing their usual function, become safety hangers for the major portion of the brake rigging, thus reducing the possibility of derailment caused by brake rigging dropping on the track. While the possibility of disconnected brake parts dropping on the track is greatly reduced, the danger is further reduced on account of the clasp brake parts being much lighter than those of the single shoe type. Careful investigation of the complaints of roughly handled pas-

senger trains indicate that most of these troubles are due largely to non-uniform braking power and time in which it is developed as a result of improper piston travel. The clasp brake, by largely reducing "false" piston travel, affords the most favorable possible conditions for the pneumatic brake apparatus to operate as intended in its design. The use of two shoes per wheel eliminates the journal bearing and pedestal reactions necessary to withstand the high pressures imposed by the use of a shoe on but one side of the wheel.

As twice the number of shoes are provided to do the work required of the brake, the improved results mentioned are accompanied by a substantial decrease in cost of brake shoe material and by a proper design and construction of the brake rigging a low maintenance cost can be insured. Further and convincing evidence that the single shoe type of brake is being considered inadequate to the requirements of modern heavy passenger cars is found in the fact that a total of over 1,500 passenger cars of various roads have been equipped with clasp brake rigging during the last three or four years. Twelve of the large trunk lines of the country have 50 or more clasp brake cars in regular service on their lines.

The requirements of the truck construction, brake shoe location and capacity to absorb heat, the per cent braking ratio and intended air brake performance are all factors in determining what weight of car warrants the change from one to two shoes per wheel. The conclusions from the L. S. & M. S. tests were, that for 12 wheel cars, 149,000 lbs. For 8 wheel cars, 100,000 lbs. These figures were based on the assumption that 18,000 lbs. pressure per brake shoe should not be exceeded and that the rigging efficiency is 85 per cent.

The M. C. B. Committee on train brake and signal equipment recommended in 1915 that the limit of one shoe per wheel be for four-wheel truck cars, 96,000 lbs. For six-wheel truck cars, 136,000 lbs. This was adopted as recommended practice of the association by a vote of three to one in favor of the clasp brakes.

During the Pennsylvania-Westinghouse Brake Tests of 1913, an ingenious arrangement was devised to measure the pressure delivered to the brake shoes by means of the impressions made by a hardened steel ball in a soft steel plate of known hardness, inserted in the brake rigging as near the brake shoe as possible. While the values observed were vitiated by the disturbing effects of the unavoidable vibrations, etc., the data secured in the standing tests was much more consistent than any before obtained. There is still lacking, however, a means for determining accurately the normal brake shoe force acutally delivered to the wheel. The data secured during the 1913 tests, though unsatisfactory in many respects, indicated that in an emergency application, 125 to 150 per cent braking ratio, the particular rigging installation tested, actually delivered to the wheel approximately 85 per cent of the pressure calculated from the observed brake cylinder pressure and total leverage ratio.

Air Valve Lift Gauge.

Apart from the constant addition that is being made to the devices used in the air brake, there has recently been added some valuable appliances used in the repair and testing of the parts, most of which are not only labor-saving, but the use of which insures a degree of accuracy in the details that are essential to the efficient operation of the appliance. The Westinghouse Air Brake Company has recently begun the manufacture of a perfected Air Valve Lift Gauge, for use on the 8½-inch and 10½-inch cross compound, and 9½-inch and 11-inch single stage steam-driven air compressors.

The purpose of the air valve lift gauge is to enable railway repairmen to readily determine the lift of air valves of steam-driven air compressors. In determining the lift of the upper air valve, the gauge is first applied to the top flange of the air cylinder, as illustrated in Fig. 1, and the sliding arm adjusted until its end rests against the top of the stop on the air valve, in which position it is locked by means of the thumb nut. With the arm thus locked, the gauge is applied to the valve cap, as illustrated in Fig. 2. If the gauge arm fails to touch the stop on the valve when the shoulder on the sliding bar rests upon the face of the collar, the valve has a lift greater than standard by an amount equal to the distance between the gauge arm and the stop. If this lift is greater than the maximum permissible, a repair valve having a long stop is substituted for the old valve and the stop lowered until the standard lift is reached, as indicated by the gauge.

To determine the lift of the lower air valve, the gauge is first applied to the bottom flange of the air cylinder, as illustrated in Fig. 1, and the sliding arm adjusted until its end rests against the stop in the cylinder, in which position it is locked by means of the thumb nut. With the arm thus locked, the gauge is applied to the air valve cage and air valve, as illustrated in Fig. 3, and if the valve has proper lift, the shoulder on the sliding arm will just rest upon the upper side of the collar of the air valve cage, as illustrated. If the gauge arm fails to touch the stop on the valve when the shoulder on the sliding bar rests on the collar face on the cage, the valve has a lift greater than standard by an amount equal to the distance between the stop and the gauge arm.

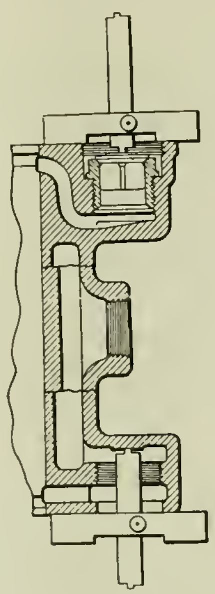


Fig. 1

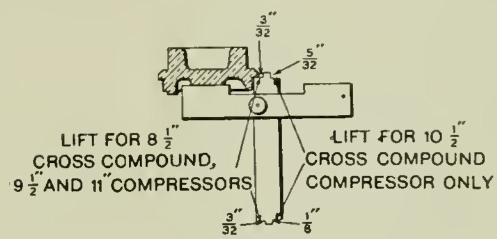


Fig. 2

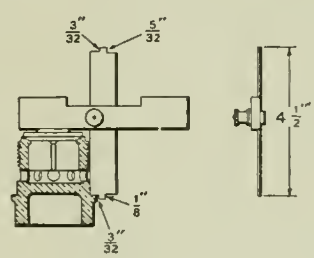


Fig. 3

DETAILS OF AIR VALVE LIFT GAUGE.

Locomotive Air Brake Inspection.

(*Continued from page 53, February, 1918.*)

225. Q.—When should an air gauge be removed, repaired and tested?

A.—Whenever it is out of register more than 3 lbs.

226. Q.—What is wrong if all hands show 135 lbs. with the brake valve handle in release position?

A.—The pump governor is out of adjustment.

227. Q.—What should be done after the pressure chamber is charged to 125 or 130 lbs.?

A.—A brake-pipe reduction just sufficient to apply the brakes should be made.

228. Q.—For what purpose?

A.—To see that the brake will operate properly under all conditions.

229. Q.—How is this done?

A.—By making this application and returning the brake valve to running position.

230. Q.—Where must the brake pipe pressure remain during the test?

A.—Above 110 lbs.

231. Q.—If the locomotive brake is in good condition, will the brake now remain applied with the brake valves in running position?

A.—Yes.

232. Q.—Will they remain applied if the brake pipe pressure is lower than 110 lbs?

A.—No.

233. Q.—Why not?

A.—Because the feed valve will open at 110 lbs. and increase the brake pipe pressure and move the equalizing valve of the distributing valve to release position.

234. Q.—What could be wrong if the brake would not remain applied after this movement and the brake pipe pressure remaining was above 115 lbs.?

A.—There would likely be a leak in the pressure chamber of the distributing valve reservoir or the equalizing slide valve or graduating valve of the distributing valve would be leaking badly enough to permit a sufficient difference in pressure for the brake pipe pressure to return the equalizing parts of the distributing valve to release position.

235. Q.—What kind of test would this really be?

A.—A test for a leaky equalizing slide valve graduating valve.

236. Q.—Why would the trouble not likely be due to a leak in the reservoir or from the equalizing slide valve or seat?

A.—Because this leakage would have been discovered while testing the reservoir with the torch, and the leaky equalizing slide valve would have been detected by a leak from the exhaust port of the automatic brake valve when the brake valve handles were in running position.

237. Q.—Would not a wrongly connected application cylinder and release pipe also cause the brake to release under this condition?

A.—Yes, but the release with the independent brake valve while the brake was applied with the automatic valve indicates that these pipes are coupled up correctly.

238. Q.—Would not a leak in the application cylinder pipes also cause this?

A.—Yes, but there was no leak in the application cylinder pipe or the brake would have released during the brake cylinder leakage test when the independent brake valve was on lap position.

239. Q.—Why is this test important?

A.—To be assured that the brake will remain applied when the engine is the second one in double heading.

240. Q.—Should this same test be made on an engine having the retarded application type of distributing value?

A.—Yes.

241. Q.—Why?

A.—It establishes a uniform practice, and the brake valve movement must be made for a comparison of the gauge hands.

242. Q.—What is the difference between the brake valve tests on such engines?

A.—The release pipe branch between the brake valves is disconnected on the engines having the retarded type of brake.

243. Q.—When will the graduating valve leakage be discovered on an engine with the retarded type of brake?

A.—At the first application of the automatic brake valve, if the leakage is of sufficient volume to cause a movement of the equalizing valve to release position.

244. Q.—Why?

A.—Because the release pipe is disconnected and a movement of the equalizing valve to release position will result in a release of the brake.

245. Q.—Is there any other test for a leaky graduating valve of the distributing valve than the one outlined for testing standard equipment?

A.—Not a very reliable one, but if the application portion of the distributing valve is sufficiently sensitive, a leaky graduating valve that will release a brake can sometimes be detected by a sharp exhaust from the distributing valve exhaust port as the equalizing valve moves to release position.

246. Q.—What will cause the hard sharp exhaust?

A.—A slight reduction in application cylinder pressure due to its expansion into the release pipe when the equalizing slide valve moves.

247. Q.—What should next be done during the brake test, after the brake has been found to remain applied with the pressure chamber overcharged and both brake valves in running position?

A.—The brake pipe reduction should be continued until the brake pipe is at 110 lbs.

248. Q.—What next?

A.—A straight 20-lb. reduction should be made.

249. Q.—For what purpose?

A.—To time the rate of equalizing reservoir reduction.

250. Q.—Through what port does this pressure reduce?

A.—Through the preliminary exhaust port.

251. Q.—What is the size of this port?

A.—1/16 of an inch.

252. Q.—What time should be consumed in reducing the pressure from 110 lbs. to 90 lbs?

A.—5½ to 6 seconds.

253. Q.—What is wrong if it takes longer than this time?

A.—The exhaust port is partly closed, or there is some leakage from the main reservoir or brake pipe into the equalizing reservoir.

254. Q.—Where is this leakage usually from?

A.—Through the middle body gasket of the brake valve or past the equalizing piston packing ring of the brake valve.

255. Q.—How can the equalizing piston packing ring be tested?

A.—If the brake valve cut out cock is in the reservoir pipe, the brake valve can be placed on lap position and the angle cock at the rear of the tender opened and the drop in equalizing reservoir pressure will indicate the amount of leakage past the packing ring.

256. Q.—Can the same thing be done if the cut out cock is in the brake pipe?

A.—Yes.

257. Q.—Can another test be made if the stop cock is in the brake pipe?

A.—Yes, by closing the cock and making a full service reduction, if the equalizing piston does not lift slightly and exhaust a very small quantity of pressure the air pressure under the equalizing piston ring must have passed the packing ring due to it leaking.

258. Q.—How can the stop cock in the brake pipe be utilized to locate leakage into the equalizing reservoir?

A.—When it is closed with the brake valve handle on lap position, any leakage into the equalizing reservoir will show almost instantly on the black hand of the large gauge and any leakage into the brake pipe under the piston will lift it and cause an escape of air from the brake pipe exhaust port.

259. Q.—What if the equalizing reservoir reduction from 110 to 90 lbs. takes place in less than 5½ seconds?

A.—It indicates that the preliminary exhaust port is too large or that there is some additional leakage from the equalizing reservoir.

260. Q.—What is the effect of too large a port?

A.—It tends to cause too rapid a reduction which contributes to undesired quick-action.

261. Q.—What is the effect of leakage from the equalizing reservoir or pipe connections?

A.—The same in regard to undesired quick action, and it also tends to cause the loss of brake pipe control when the engine is coupled to a train of cars.

262. Q.—How can this occur?

A.—When the brake valve is placed on lap position, the equalizing reservoir and brake pipe pressures are separated, and any leak from the equalizing reservoir will allow the equalizing piston to lift

and discharge a like amount from the brake pipe.

263. Q.—Why does a slight leak that is scarcely noticeable cause this on the train and does not result in the lifting of the piston when the engine is alone?

A.—On account of the greater volume of air under the equalizing piston when coupled to a train.

264. Q.—How is a leak in the equalizing reservoir usually discovered?

A.—By the lifting of the piston and the discharge of brake pipe pressure when the brake valve handle is placed on lap position.

265. Q.—What is wrong if there is a leak at the brake pipe exhaust port when the brake valve handle is in running position?

A.—Dirt on the seat of the equalizing piston, or a defective seat.

(*To be continued.*)

Train Handling.

(*Continued from page* 54, *February*, 1918.)

239. Q.—What causes about 90 per cent. of the slid flat wheels in freight service?

A.—Starting the train with some of the brakes applied.

240. Q.—How do you estimate the time required for different brake operations on long trains?

A.—In minutes instead of seconds.

241. Q.—When would it be advisable to use a watch in checking up this time?

A.—When occupying the main track, close upon the time of a first-class train.

242. Q.—Why at this time?

A.—Because at such a time 30 seconds seems about like 10 minutes.

243. Q.—Is schedule time, then, of secondary importance to careful operation in freight train braking?

A.—Yes; more time may be lost in attempting to hurry a movement than if ample time was allowed for a release of brakes.

244. Q.—How so?

A.—Jerking cars back and forth in trying to start a train with brakes applied on the rear cars does not gain in time.

245. Q.—How are you likely to lose time in this way?

A.—These same attempts to start a train usually result in an additional amount of brake pipe leakage, and even if the train can be started the rear brakes retard the speed of the train to such an extent that no time is gained in the total movement.

246. Q.—Why do air brake men always emphasize the importance of allowing ample time for the release of brakes before starting a train?

A.—Because more trains break-in-two, and wrecks have been caused by disregarding those instructions, than from any other single phase of incorrect train handling on level track.

247. Q.—What should be done if running at a low speed and a signal to proceed was received?

A.—The train should be allowed to come to a stop before an attempt was made to release brakes.

248. Q.—Can this ever be varied?

A.—It can if the train is not too long and if there are enough type K triple valves on the rear end of the train to prevent a run out of the slack at the head end.

249. Q.—Spuppose that on a descending grade the brake valve has been in release position for about 15 or 20 seconds, where should it be brought for the feed valve to control the pressure passing to the brake pipe?

A.—To holding position.

250. Q.—Why?

A.—So that the engine brake will be held applied with the K triple valves at the head end of the train.

251. Q.—What about releasing when the rear end of the train happens to be rounding a sharp curve?

A.—As a general thing it should be avoided if possible.

252. Q.—Why?

A.—As the effect of the curve sets up a considerable amount of retardation in addition to the brakes at the rear end.

253. Q.—How is the independent brake valve to be handled in train braking?

A.—If used, it is to be graduated on, and when released to be graduated off.

254. Q.—How does grade braking differ from level track braking?

A.—Trains are usually very much shorter, and the chief consideration is to hold the train against the possibility of a runaway.

255. Q.—What should be done before descending a heavy grade?

A.—A standing test of brakes should be made in accordance with the instructions covering brake operation on that particular division.

256. Q.—In descending, when should the first application be made?

A.—As soon as the train tips over the summit of the hill.

257. Q.—About how much brake pipe reduction?

A.—About 8 lbs. on the average train.

258. Q.—What should be observed at this time?

A.—That the brakes are holding, and that the length of the brake pipe exhaust corresponds with the number of cars in the train.

259. Q.—Why will the brake pipe exhaust be shorter with K triple valves than if all are type H valves?

A.—Because K triple valves absorb a considerable amount of brake pipe pressure by admitting it to the brake cylinders, thus leaving less of the brake pipe volume to pass through the brake valve exhaust port.

260. Q.—How much difference is there in the length of this exhaust with all H valves in one case and all K valves in another?

A.—With K valves the exhaust from the brake valve will only be about one-half as long.

261. Q.—What if the first reduction does not materially check the speed of the train?

A.—Make a further reduction in the brake pipe pressure.

262. Q.—What if the brakes are not holding as they should?

A.—Make a full service brake application and call for hand brakes.

263. Q.—What are retaining valves used for?

A.—To retain a certain amount of the brake cylinder pressure while the triple valves are in release position and recharging the auxiliary reservoirs for a subsequent brake application.

264. Q.—When are they used?

A.—Only in descending heavy grades.

265. Q.—How many of them are used in a train?

A.—It is intended to use enough to prevent any material increase in the speed of the train while reservoirs are recharging.

266. Q.—What governs the number to be used?

A.—The number of cars in the train and the type of valve, and this is covered by the instructions for brake operation on the division on which the grade is located.

267. Q.—What is to be done if the first brake-pipe reduction reduces the speed of the train to the desired amount?

A.—The brakes are to be released and reservoirs recharged.

268. Q.—How?

A. By moving the brake valve to release position and leaving it there until ready to re-apply.

269. Q.—Why leave the handle in release position?

A.—To have a wide-open port for the prompt recharge of the auxiliary reservoirs.

270. Q.—What will control the brake-pipe pressure?

A.—The excess pressure governor top.

271. Q.—How?

A.—The feed valve pipe will contain pressure controlled by the feed valve, so that the brake-pipe pressure can rise but 20 lbs. higher than normal with the handle in release position, regardless of the maximum main reservoir pressure carried.

272. Q.—Why is 20 lbs. more brake-pipe pressure desirable in descending grades?

A.—It provides a greater factor of safety.

273. Q.—In what way?

A.—It permits of a full service or 20-lb. brake application without lowering the brake-pipe pressure below that normally

carried, so that in the event that a stop is required immediately after an application and release, normal braking effect may be immediately obtained.

274. Q.—Are there any special instructions as to the pressure to be obtained in the brake pipe before starting the descent of a heavy grade?

A.—Some roads specify that the brake valve be placed in release position and left there until the brake pipe and auxiliary reservoirs are charged to 90 or 100 lbs. before the descent is begun.

275. Q.—How is the brake-pipe pressure maintained on descending grades?

A.—By making the brake applications as light as consistent or necessary and recharging as frequently as possible.

276. Q.—Will a 10-lb. brake-pipe reduction, from 90 to 70 lbs., result in more brake-cylinder pressure than a reduction from 70 lbs. to 50 lbs.?

A.—No.

277. Q.—Why not?

A.—Because the same number of cubic inches of free air leaves the auxiliary reservoir in each case.

278. Q.—How can a higher brake-cylinder pressure be derived from 90 lbs. brake-pipe pressure than from 70 lbs.?

A.—By a brake-pipe reduction that produces equalization between the brake cylinder and the auxiliary reservoir.

279. Q.—How much brake-pipe reduction will be required from a 90-lb. brake-pipe pressure?

A.—From 24 to 27 lbs.

280. Q.—From 70 lbs. brake pipe and auxiliary reservoir pressure?

A.—From 20 to 23 lbs.

281. Q.—Why the margin of three pounds?

A.—It allows for difference in piston travel.

282. Q.—Which will require the heaviest reduction to produce equalization?

A.—The cylinder with the longest piston travel.

283. Q.—How is the independent brake handled in grade braking?

A.—It is graduated off as soon as the car brakes are felt to be holding.

284. Q.—Why?

A.—To prevent overheating the driving wheel tires.

285. Q.—When is it re-applied?

A.—Just before releasing and recharging the car brakes.

286. Q.—What is the engine brake then used for?

A.—To assist in holding the train while the auxiliary reservoirs are being recharged.

287. Q.—Why are damaging shocks not so likely to occur in grade braking?

A.—Because retaining valves and possibly set hand-brakes on the head cars of the train prevent any rapid change in slack.

(*To be continued.*)

Car Brake Inspection.

(*Continued from page* 55, *February*, 1918.)

246. Q.—Sometimes there is a question whether undesired quick action has really occurred, how can you tell whether the brakes are actually working in undesired quick action?

A.—Usually by the sudden movement of the brake pistons and the opening of the high speed reducing valves.

247. Q.—Will not the reducing valves open whether the brake works in quick action or if a 25-lb. brake pipe reduction is made?

A.—Yes, but in one case the reducing valve will be wide open, reducing brake cylinder pressure about as fast as it can flow through the service port of the triple valve, and if the brake works in quick action there will be a restricted blow at the start which will increase in volume as the brake cylinder pressure reduces.

248. Q.—What kind of an application can be made to be sure if there is any doubt about the action of the brake?

A.—The brake can be applied with a 12- or 15-lb. brake pipe reduction, and under this condition the reducing valve will not open unless the brake has gone into quick action.

249. Q.—How will it be positively determined if there is a P. C. equipment or a universal valve in the train?

A.—Either of these valves will exhaust practically all of the brake pipe pressure to the atmosphere when they work in quick action.

250. Q.—How will the L. N. brake equipment act when the triple valve assumes the quick action position?

A.—The safety valve of the distributing valve will be cut off from communication with the brake cylinder and the safety valve will not pop.

251. Q.—If the undesired quick action continues until after it cannot be found in the five cars next to the engine, what kind of a test should be made?

A.—The angle cock at the rear of the tender should be closed to ascertain whether or not the trouble may be with the engine equipment.

252. Q.—After a terminal test has been made and it is necessary to close an angle cock in the brake pipe for renewing a hose gasket or for any purpose whatever, what must be done before the train leaves?

A.—Another test of the brakes must be made.

253. Q.—Why?

A.—It must be absolutely known before leaving that all of the brake can be operated that is, applied and released from the locomotive and this is to be determined only by a test.

254. Q.—Why is this an absolute rule?

A.—To have inspectors in a position to be positive that no angle cocks were closed or any repairs made to any part of the brake equipment after the brakes were tested and the engineer has been notified that all brakes are in good condition.

255. Q.—What controls the operation of a brake on a car?

A.—The triple valve or a similar operating valve.

256. Q.—Why is it called a triple valve?

A.—Because it controls a flow of air from the brake pipe to the auxiliary reservoir for charging up, a flow of air from the auxiliary reservoir to the brake cylinder for applying the brake and from the brake cylinder to the atmosphere for releasing the brake.

257. Q.—From instruction pamphlets it has been easy to learn the names of parts and the operation of a brake, what is the principle upon which an automatic brake operates?

A.—Upon the creation of a differential in pressure between two stored volumes of compressed air.

258. Q.—What usually separates these pressures?

A.—A piston with a packing ring intended to be an air-tight fit.

259. Q.—How is the differential in pressure required to operate a triple valve obtained.

A.—By alternately increasing and decreasing the pressure carried in the brake-pipe.

260. Q.—Does a reduction in brake-pipe pressure apply the brake?

A.—Not necessarily.

261. Q.—Why not?

A.—The rate of reduction may not be rapid enough or leakage from one volume to another may prevent the attainment of the necessary differential in pressure.

262. Q.—What applies a brake that is in an operative condition?

A.—A difference in pressure between the auxiliary reservoir and the brake pipe great enough to overcome the frictional resistance of the piston and slide valve to movement.

263. Q.—Does an increase in brake pipe pressure result in a release of the brake?

A.—Not necessarily.

264. Q.—Why not?

A.—The differential in pressure necessary to move the triple valve piston and slide valve to release position may not be obtained.

265. Q.—What would prevent it?

A.—An increase that would be at too slow a rate and leakage between the volumes or past the triple valve piston and packing ring or a reduction in pressure so light that the proper difference in pressure required for a release could not be obtained.

266. Q.—How is a brake in an operative condition released?

A.—By obtaining a sufficient difference in pressure between the auxiliary reservoir and the brake pipe to overcome the resistance of the parts to movement.

267. Q.—How may this difference in pressure be obtained?

A.—By increasing brakepipe pressure at a sufficiently rapid rate or by reducing pressure in the auxiliary reservoir.

268. Q.—How may brake pipe pressure be reduced for an application of brake?

A.—By means of the locomotive brake valve, a conductor's valve or by the opening of an angle cock to discharge brake pipe pressure to the atmosphere.

269. Q.—What two different rates of brake pipe reduction are used in applying brakes?

A.—Service and emergency.

270. Q.—What is the service rate used for?

A.—For making ordinary stops.

271. Q.—What is the emergency rate used for?

A.—When the shortest possible stop is desired, that is, in cases of emergency.

272. Q.—What is the proper length of piston travel for the brake cylinder on cars of single shoe brake gear?

A.—About 7 in. standing travel.

273. Q.—If it is 6½ ins. standing on the average car, about what will it be when the car is running?

A.—Very nearly 8 ins.

274. Q.—What causes this difference in travel?

A.—Lost motion in the trucks, journal boxes and through the braking effect tending to pull the trucks closer together when the train or car is running.

275. Q.—What is this difference in travel usually called?

A.—False, or fake piston travel.

276. Q.—How does piston travel affect the pressure that will be obtained in the brake cylinder from a fixed auxiliary reservoir volume?

A.—The longer the travel, the less pressure that will be developed from a given drop in the pressure in the auxiliary reservoir.

277. Q.—Why is this?

A.—Because the longer the travel, the greater the space in the cylinder consequently the greater the volume of free air that will be required to develop a certain cylinder pressure.

278. Q.—What is the effect of too long a piston travel?

A.—Inefficient brake.

279. Q.—Of too short a piston travel?

A.—Insufficient brake shoe clearance, and too high a brake cylinder pressure consistent with the specified brake pipe reduction.

280. Q.—What is the effect of too high a brake cylinder pressure for a given amount of brake pipe reduction or rather that will not correspond with the amount of brake pipe reduction?

A.—It tends to cause rough handling, and shocks to trains.

(*To be continued.*)

Heat Treatment of Steel

At a recent meeting of the American Drop Forge Association, Mr. J. H. Herron read a paper on the "Structural Changes During Heat Testing." He said, among other things, that in considering the subject of heat treatment of forgings it is necessary that we understand the term "heat treatment"—where it begins and what it means. On receiving any kind of treatment which is corrective through heat it should be called steel which has received heat treatment. The subject of heat treatment of materials is very important. In considering the subject of heat treatment there are a number of features which refer to the treatment and the manner of this treatment. First the fundamental heat treatment, which is distinguished from the reheating. The critical point is the point where some structural change takes place, not only where alloying is concerned. It is the boundary between one condition and another in the elements contained in the metal, where a structural change, entirely new, takes place. Where originally there was a high carbon steel, its structure may be changed so as to reduce it to a low carbon steel, or the reverse, certain changes take place, and the points where the changes occur are the critical points on the heat curve. We are dealing now only with the heat curves, which do not in every instance affect every metal, yet in most instances the structural condition of the metal is always affected by heat. Where changes occur they are called points of re-fusion, because they show some increase in heat, and from the outset the steel has passed through the critical point. It is necessary to bring the steel to this or that critical point in order to change its structure. It is the critical point we desire to know of if there is going to be any change.

As a matter of fact, in many cases steel which will show marked properties of hardness these must be observed to be understood, because the critical point has developed at a time when not expected or anticipated. The critical point may be reached quickly or slowly, and to guard against a too severe structural change, the utmost care must be exercised to see when the change takes place. If we discover that the critical point is likely to be rapidly reached, we do not bring it to the critical point, but to some other place along the line. In all instances, however, no marked structural change occurs unless the steel has been heated decidedly above the critical point. So that, unless it is specifically desired to bring the steel, after the first heat, to a point above the critical point, so as to effect a structural change, it is not done.

Ordinary forge steel of about 30 point carbon, with steel is heated above the critical point. One may not be able to use that steel in a die because it has lost its original properties and is no longer of value because of its extreme softness. One will find that steel as high as 40 point carbon which has undergone a structural change may be practically useless to machine because that change may make is too soft and practically worthless. On the other hand, one may have permitted it to cool too slowly in the cooling operation. Steel of 30 point carbon can be taken out of the furnace and piled on the ground when hot and will serve every purpose of the machine shop, but it may be so soft as to be unusable if allowed to cool very slowly. The hardness and the structural value, in that respect, will be largely determined by the rapidity with which it is allowed to cool. In the regular heat treatment, one can heat steel above the critical point, and if the metal is not permitted to cool too fast or too slowly, as soon as it has passed through the critical range, the condition is arrested. In the heat operation, increase the heat and the metal begins to lose its hardness, and if it is not proportionate with the temperature to which it is subjected—say at 1,300 degs. if allowed to cool rapidly afterward it will not lose the initial hardness it would gain by quelching.

We have certain elements affecting the critical points in steel. As stated before, the carbon is more affected than anything. So that, where we have 90 point carbon steel the critical point is comparatively low; while with soft steel or steel with less than 10 per cent carbon, the critical point is rather high. One must first select the temperature for the combustion of the steel. The rest is judgment after selecting the temperature. The critical point varies. Carbon steels are determined by the temperature to which they may be subjected.

Some of these steels will be subjected to the critical point at a very low temperature, others at a very high temperature, while in other cases the physical condition of the metal remains the same after having passed the critical point. We have all these elements to take into consideration, and which should be taken into consideration in the heat treatment of forgings. We have got to deal with chromium in steel, which is very difficult of fusion. Vanadium in steel, which produces a structural inertia in the steel and requires that the steel in which it is present shall be subjected to a very much higher temperature to treat it satisfactorily, than other steels, although the steel with the chromium in it has practically similar properties, so that they are about the same. We usually treat these steels with from 100 to 200 degs. Fah. higher temperature, and subject them to that

temperature for a greater length of time than the softer and less brittle steels, which we treat at a lower temperature. To make any structural change, therefore, there are two elements to be taken into consideration, these are temperature and time.

To come specifically to the point of heat treatment of drop forgings, we all know that the tendency is to heat steel for drop forgings to a very high temperature. It flows very much better in the dies. The fact is, as the reports sometimes tell us, they melt in the dies. However, that may be exaggerated, but we do heat to too great a temperature. The steel is heated between 2,000 and 2,500 degs. in most drop forging operations.

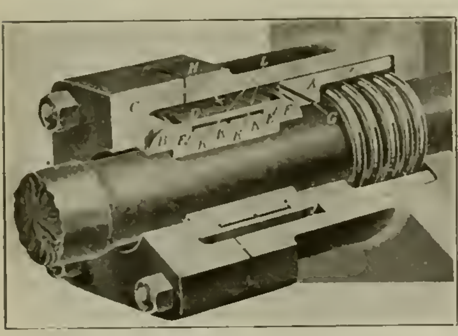
If one wishes to correct physical conditions already existing it becomes necessary to heat the forgings to a proper temperature and then draw them back to their original structural properties. Then the steel can be heated again and again.

In heat treatment of steel great care should be exercised. If overheated disastrous effects may be produced. If high in carbon the surface may crack. In some steels expansion occurs below the critical point, at other times above. It may be of interest to many to learn about the elements and physical properties of steel. Nickel is considered as a depressent. In high carbon steel manganese adds to the strength of the surface. High carbon manganese is good for springs. Manganese gives resiliency, but nickel toughens it or reduces the resiliency. Nickel tends to increase the strength without decreasing the toughness. That is, it increases the elastic limit without altering the strength. Chromium tends to harden the steel without increasing its brittleness. If hardness is desired, chromium produces it, if we do not wish to increase its brittleness. Vanadium is used where steel is subjected to dynamic stresses. Carbon increases hardness and makes good steel statically. One cannot have good static and good dynamic properties at the same time. If one wants dynamic properties in steel, vanadium is desirable.

Piston Rod and Valve Rod Packing

Details of Construction and Maintenance

Any one familiar with the locomotive knows that the loss of steam occasioned by leaks in piston packing is considerable. It is not owing to mechanical defects in the packing, as almost all packing, either on piston or valve rods, has the quality of adjusting itself to the rod and maintaining a steam-tight joint at all times. The packing usually consists of a gland, ball-joint, vibrating cup, three soft metal rings, known as one ring, follower, preventer, spring swab cup and oil cup. The gland is for the purpose of holding the packing in the stuffing box, and furnishing a bearing or seat for the ball ring which forms a universal joint between the vibrating cup and the gland. Hence, the packing is, properly speaking, a floating packing, and follows the rod whether the rod be exactly central or not. The vibrating cup holds the packing rings in their proper position. The ring is of soft metal, and is the only wearing part of the packing, as no other part of the device should come in contact with the moving rod. The flange follower is used to transmit the spring pressure to the packing ring or rings, and to follow up the packing as the inevitable wear takes place.



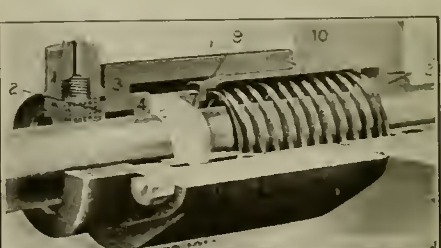
TROJAN METALLIC PISTON ROD PACKING.

It is not as generally known as it should be that the chief purpose of the spring is to keep packing rings and all joints in proper position when steam is shut off, and is not as is supposed by many for the sole purpose of setting in the packing as the wear takes place. The steam presses the rings in to the piston. At the same time the spring should be strong enough to hold the packing firmly together, as without the spring there would be nothing to prevent the packing from becoming disarranged when the steam pressure is shut off. The preventer is for the purpose of only allowing the packing to move backward and forward about 1-16 of an inch, thereby insuring its perfect flexibility.

When the packing becomes dry or the rod becomes rough, if it were not for this preventer the packing would hang to the rod on its inward stroke, compressing the spring until the coils became tightened, and when the engine took steam the packing would be forced up against the gland with such force as to crush the packing or perhaps break the gland. The preventer also furnishes a close fitting casing around the outside of the spring, and never allows the spring to come in contact with the rod by allowing the spring to become cocked. The swab cup forms an important function in furnishing a reliable lubrication to the packing, as the oil cups do not always accomplish the purpose intended, as cups are not infrequently clogged with dust or cinders, and pipes may become choked or broken off. Both should receive careful attention.

Leaks in the rings usually occur when too much material is cut out of them. When in proper working order they should come solidly together. They will last much longer in this way than when separated at the joints. They should never be cut after the first time, and then 1-16 of an inch is enough. Leaks also occur if the piston is much worn. Tapering and shouldering of the piston is inevitable, and a departure of 1-32 of an inch at any part of the piston from the exact truth will cause a considerable leak. It should always be remembered that neither the packing or the piston will endure forever. Much time and waste of steam will be saved by trueing up the rods and renewing the packing. This precaution with good lubrication will insure tight packing.

The rings should be machined all over. The three rings should be faced separately, and the outside ring should conform exactly to the vibrating cup. The rings should be sawed apart with a 1-16 inch saw. On no occasion should one new ring be placed with other older and worn rings. They can never be made to fit properly. It should be noted that they fit exactly on the rod. Leaks also occur by foreign matter getting in the joints, and frequent cleaning is necessary, and possibly a refitting of the joints. The nearer the exact center the rod is the better will the result be. This is especially true of the valve rod, which in the case of slide valves, has a tendency to fall repidly below the center, and should be kept in place by the use of liners under the valve yoke. The joints in the rings should be separated when placed in the vibrating cup, and a leak should never be allowed to continue until a more convenient season. The loss by packing leaks is exactly the same as if a stream of coal and another of water were continually running out of the coal box and tank with this difference that the loss is lost forever.



KING TYPE METALLIC VALVE STEM PACKING.

Electrical Department

The Automatic Railway Sub-Station—No Voltage Release Connections—Track Circuiting on Electrified Railroads

Last month we took up the rotary converter and explained the design and construction of this useful piece of mechanism. The rotary converter or synchronous converter, as it is sometimes called, is a rotating machine used to convert or change the alternating current lead into the substation building into direct current, and which is also stepped down to low voltage by the transformers. We pointed out that there are three different methods used in starting rotary converters, namely:

(1) Motor starting; (2) direct current self-starting; (3) alternating current self-starting. The operation of starting up a rotating converter in the usual sub-station is done by the operator. Switches are closed to start the machine, and when the proper speed is reached, other switches are closed connecting the rotary to the source of supply. It is very interesting to see the experienced operator manipulate the switches and control—the whole process being done with precision and regularity.

A little thought will show one that the duties of the operator in the moderately sized sub-station are not specially strenuous. There are many hours of leisure, with no machines to cut in or out, to care for varying load conditions, and no interruptions. The operator must, however, be alert, as overload conditions on the line may cause circuit-breakers to open, and they must be closed immediately, and there are many little things which may occur at any moment, requiring immediate attention and adjustment. Usually the 24 hours is divided into three shifts of 8 hours each, and thus 3 operators are required.

The overhead expense of maintaining these three operators is a considerable item in substations, where the service is light and the operating expense would be reduced if the operators could be eliminated. Another saving could be obtained if the "no-load" losses were eliminated. Let us explain. In the case of a railroad substation, furnishing current to an electric railway where the service was infrequent, say a car or train every half hour, the load would be on the substation only a few minutes out of each hour. The rest of the time the substation would be running idle, waiting for the next train. Although the substation might not be delivering any direct current to the trolley-wire or third rail, some alternating current power would be required to keep the rotary running and supply the losses. These "no-load" losses may, and do run up in certain cases, to a large amount. They could be eliminated by shutting down the substation and starting it up when the train was due to run. It would be extremely difficult to do this with operators. Trains or cars are not always at the same place at the same time each day or hour, and moreover, extra cars or trains are frequently dispatched. The only way to reduce the operating expense, that is eliminating the operators and shutting down the substation, when not required, is to make the substation automatic in every detail so that it will start up, run, shut down, stop and care for all emergency conditions such as over-loads on circuit-breakers, etc., without the aid or the presence of an operator. This seems at first sight to be impossible, but it has nevertheless been accomplished by the two big electrical manufacturing companies. We will describe the method used in the Westinghouse scheme.

The equipment duplicates in every way the manual operation of the substation apparatus. Switches are closed in the same sequence, and each succeeding switch-moving operation is dependent upon the proper functioning of the preceeding operation. The control has been designed to duplicate manual operation. It starts and shuts down the apparatus depending upon the load demand upon the substation.

We will assume that the road is short and that there is more than the one automatic substation to be considered. To get an idea of its operation, let us consider that there is no load on the substation so that it is shut down, that is, the rotary is not running. In railway work, the substations are "tied together." By this term we mean that they are all connected to the trolley wire or third rail, which is continuous. Therefore, while the automatic substation is not running, still there is voltage on the trolley wire furnished from one of the other adjacent substations. Now it is the value of this voltage which governs the starting up of the automatic station. We will call the automatic station "A" and the adjacent station "B." With no car or train operating between "B" and "A," full voltage (we will assume 600 volts) will be on the trolley-wire. A train starting from "B" running toward "A" will be obtaining (when at "B") the full voltage, but as it runs toward "A" will be getting less and less voltage, due to the voltage drop in the trolley wire and feeder. The voltage at "A" will drop also, and will be the same as at the car, since the car is between "A" and "B." The further the car is from "B," the greater is the drop. Too low voltage is undesirable, so that the automatic station "A" should start up before the limit is reached and help to supply the current to the car. With both stations running the current is divided and the voltage drop is less.

As mentioned above, it is the value of the voltage which starts up the station "A." A voltmeter fitted with a contact is set so that when the voltage falls to some predetermined value, say 75 per cent. of normal or below, the contacts are closed and the rotary is started, and when at speed, direct current is supplied to the trolley. The substation will keep running as long as power is required. To avoid the station shutting down every time the power is shut off for a few seconds, a relay which can be set, is used, making it necessary for the current to be off say four or five minutes before the station will finally shut down.

Protection has been provided for every condition or combination of circumstances which can arise, even though they may be anticipated very frequently. The following are some of the principal protective features:

First. Should trouble develop anywhere between the high tension side of the transformers and the DC side, the alternating current oil circuit-breaker will open, thereby cutting off AC power.

Second. Should the voltage on the AC side drop to too low a value, the AC breaker will open.

Third. Thermostats are placed in the machine bearings so that should these bearings heat, the thermostats will shut down the station by tripping the AC breaker.

Fourth. A mechanical speed limit device is fitted to the rotating armature so that if the speed exceeds a dangerous point, the AC breaker will open.

No Voltage Control

On page 84 of the present issue, reference is made to the no voltage release, which is adapted to machine tools to afford protection for the workman, in case the power is shut off unknown to him. Machine tools are driven by motors operating from either DC or AC current, so that there are two arrangements to consider. First, the no voltage release for DC motors and second, no voltage release for AC motors.

With motors operating on DC (direct current), starting rheostats are used to regulate the flow of current to the motors. This allows the motor to start up smoothly and evenly and gain in speed until full speed is reached. This is like the controller on a trolley-car. A diagram of a starting rheostat is given in Fig. 1. When the handle "H" is in the position

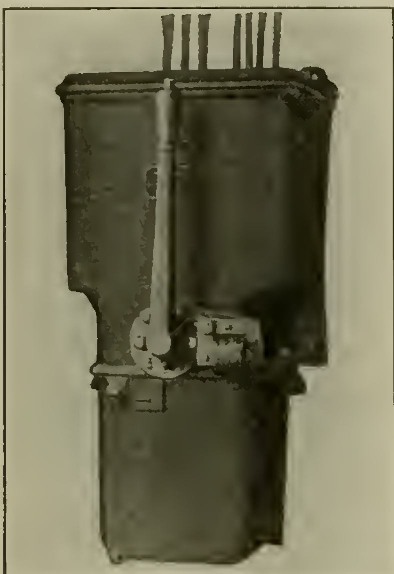


FIG. 2. AUTO-STARTER WITH NO VOLTAGE RELEASE.

shown there is no current flowing to the motor, although the motor switch "S" is closed. When the handle is at the extreme right all of the starting resistance is cut out and the motor is running at full speed. A spring is fitted to the handle tending to return it to the off position so that with the switch "S" open, the handle would fly back to the off position if pulled over to the extreme right or running position and then released. With power on, that is, switch "S" closed, it would be impossible to hold the handle in the running position all the time when the motor is running, so that provision must be made to keep it in the running position. This is accomplished by an electromagnet "I" mounted on the rheostat and the handle is fitted with a strip of iron or steel "R." The electromagnet is connected from across the line so that when power is on the motor, it is energized. The iron strip "R" is so mounted that when the handle is in the running position it engages or touches the poles of the electromagnet and the handle is held in the running position, due to the attraction of the magnet. Now it is clearly seen what occurs when power is turned off. There will be no longer any current flowing through the magnet, therefore there will be no attraction of the magnet for the iron bar "R" and the spring returns the handle to the off position. Before the motor can start the handle must be thrown on again. This is the no voltage release and the machine tool operator is protected by the fact that although he did not shut off the power, he is forced to turn it on if he wishes his machine to start.

In the case of the AC motors, an auxiliary device is used for starting. This device is called an auto-starter; the outside view is shown by Fig. 2. These starters reduce the initial primary voltage and at the same time supply the increased starting current needed without drawing excessive current from the line. The no voltage release device consists of a small solenoid with a laminated core and a pivoted armature, all mounted on the outside of the case. An extension from the armature locks the handle in the running position. The coil is connected across one phase of the running circuit. A very small current holds the handle locked, because the air gap is closed. On failure of the voltage from the outside the handle is released and returns automatically to the off position.

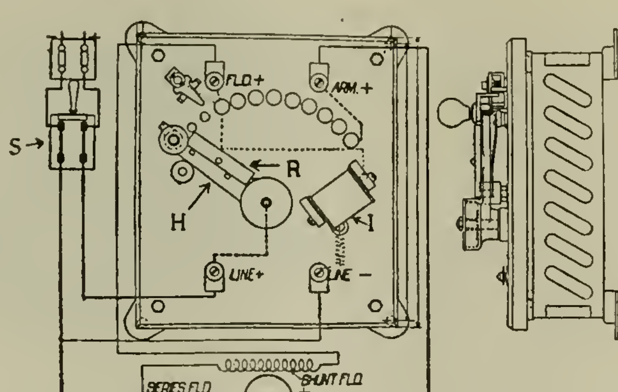


FIG 1. STARTING RHEOSTAT FOR DC MOTORS WITH NO-VOLTAGE RELEASE.

This release is invariable whether the voltage falls slowly or rapidly.

Track Circuiting on Electrified Railroads.

How is it that the main current, used by the electric locomotives and which is returning back to the power-house along the running rails, can pass through the track bonds without difficulty, while the current used for the signals cannot pass? This is a most interesting point and one worthy of careful study. The most interesting application of electrically operated signals occurs when they are used in connection with electrified roads. Alternating current is used on the signal system. Not only do we meet all the problems encountered in the steam road track circuit, but it is necessary to provide an electrically continuous return path for the main current from block to block, while in a signalling sense, preserving between blocks the insulation necessary for operation.

Since there are limitations to the use of the single rail circuits we will consider only the double rail track circuit. The novel feature of the double rail track circuit is the impedance bond installed in the track circuit to provide a path for the main current (used by the locomotives) and which current goes back to the powerhouse. It is this bond which prevents the two different currents from mixing, so to speak, and we will explain how this impedance bond acts and why it allows the passage of the power or propulsion D. C. current, and chokes back the signal current, which is A. C.

There are two general systems of electrification, namely, alternating current (AC) and direct current (DC). We will consider the DC system in detail and point out the slight difference which exists in itself equally, under normal conditions, between the two running rails, so that the direct current flowing from point (a) into the bond at one end is equal to the direct current flowing from point (b) into the other end. The number of turns of the winding from the (a) end to the point (c) is the same as the number from the (b) end to the point (c), where a tap is brought out for connection to the other adjacent bond. The two direct currents unite at the point (c), flow into the other bond at point (e), where it divides equally, one-half flowing out at (f) and the other half at (g).

A study of Fig. 1 shows that the two equal currents are flowing in opposite directions around the laminated core and therefore neutralize each other as far as the magnetizing action is concerned and no magnetic flux will flow in the iron core. The lines of force are practically destroyed, which the windings would otherwise produce. There is then no impedance to the flow of the propulsion current. It flows freely through, and on to the power house. The subject of impedance, inductance, etc., was carefully explained in the March and April, 1917, issues. It was there pointed out that when a current flows in a wire, that wire is surrounded by magnet lines of force or a flux; that these flux lines radiate outward concentrically, just like ripples of water formed by the drop-

ping of a stone into a pond. The strength of this magnetic field depends on the strength of the current flowing in the wire. If the current alters its strength, the field is also altered, increasing and decreasing with the current and becoming non-existing when the current ceases. We have pointed out in the above mentioned articles that the self-induction of a coil is due to the lines of force from each turn of a coil cutting the case of the AC system. Look at Fig. 1. The track rails are shown by RR and TT. The insulating pieces "I" separate the track into blocks, which are only connected together electrically by the impedance bonds "B." The signal transmission line carrying AC, 60 or 25 cycles, to the various blocks for the operation of the signals, is also included. For transmission purposes it is necessary to use a voltage very much higher than can be used on the track circuit, so that for each block a step-down transformer is required.

To understand the principle of operation, we should be acquainted with the construction of the bonds "B." These are called bonds because they are low resistance connectors between adjacent track circuits, and they are called impedance bonds because they impede, or choke back the flow of the AC signalling current from one rail to the other of the same track circuit across which they are connected. The impedance bond consists of a laminated iron core, over which is wound two heavy copper windings. The schematic arrangement of the winding on the bond and the method used in connecting up the two bonds at each insulated section is shown in Fig. 1.

Let us suppose that there is an electric locomotive somewhere to the right of Fig. 1, with the power-house to the left so that the main or propulsion current flowing back to the powerhouse is in the direction along the rails from right to left. The arrows show the direction of the propulsion current in the track and through the bonds at the left. Since the current flow is the same in all the bonds it is only necessary to consider one. The propulsion current divides the other turns, thereby producing in them a secondary electromotive force or voltage which will oppose the impressed voltage driving the current through the coil. This opposing voltage nearly offsets the impressed voltage and cuts the current down to nearly a negligable quantity.

As mentioned above, the two main direct currents in the bond neutralize each other so that there is no flux in the iron core and hence no self-induction as far as the direct current circuit is concerned. However, the condition is different with the AC signal circuit. To avoid confusion, but realizing that the condition still exists in the bond at the left, we will consider only the AC signal current in the bond at the right. This carries alternating current, reversing in direction many times a minute, so that the direction of current flow, as shown by the arrows, is the instantaneous direction. The alternating current enters the bond at point (h) and leaves it at point (j), all of the turns being in series. There is no alternating current flowing through the jumper over to the other bond, as there is no circuit. This latter bond connects with another section of rail, insulated from the block we are considering and supplied with AC current from another transformer.

The turns being in series, there is no neutralizing effect so that the core is energized and a high self-induction exists. The result is that very little AC current can flow through.

As mentioned above, the DC and AC current exists in the same bond at the same time, but do not mix or affect each other. The bond is necessary to provide a means of connecting the rails together around the insulating joints, placed in the rails to divide the road into blocks so as to allow the main current to return to the powerhouse or substations. Were it not for their choking effect, the bonds would act as a short circuit across the track circuit. It must be remembered that these bonds do not absolutely insulate one rail from the other. There is at all times a certain amount of signalling current which leaks across from one rail to the other, depending on the AC voltage and the impedance of the bonds.

The arrangement is the same in the case of alternating current electrifications. All AC roads in this country employ an alternating current of 25 cycles so that the signals employ an alternating current of 60 cycles. While the propulsion current is of an alternating character, still it is divided up, as is the DC current, and between the two opposing windings and is neutralized. The iron core remains unmagnetized as far as the 25 cycles current is concerned and the effect of the 60-cycle signal current is same as explained above.

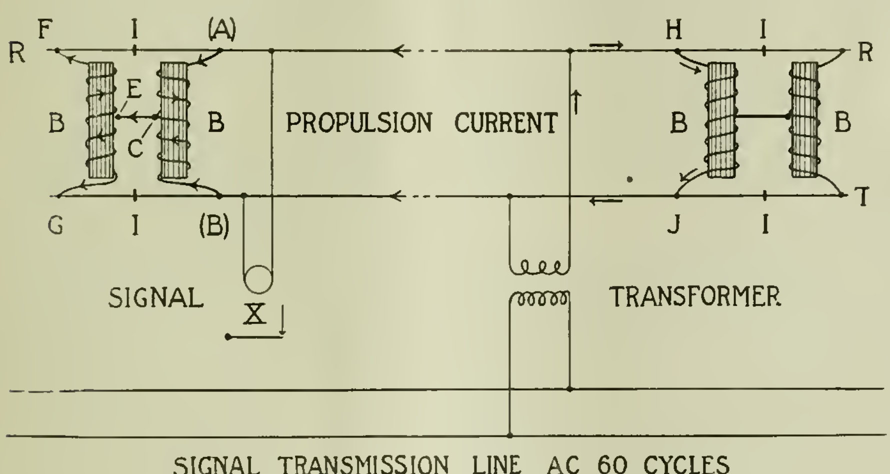


FIG. 1—IMPEDENCE BOND CONNECTIONS, AND CURRENT DIAGRAM.

French Railroad Investments in Spain.

The *Wall Street Journal* states that in five years the French government will turn over to the Spanish nation all the leading railroads in Spain, which the republic built and administered under a 99-year lease. It is interesting to note that the roads have cost France more than was expected, and some of the most expensive tunneling in the world was done in northern Spain, where in some sections as many as 20 tunnels within a few miles had to be driven through the mountains. Many of the lines are antiquated, single track affairs. French investments in Russian railroads have been tragic. For instance, it is estimated that France advanced $800,000,000 to Russia to construct strategical railroads, particularly in connection with troop moving. Not a dollar of this money, apparently, was spent in railroad building, and it was this lack of transportation which in part led to the military downfall of Russia. Legislative tangles and lack of imperial ukases prevented the French cash from being utilized for what it was intended.

U. S. Railway Equipment in France.

Some idea of the scope of the work of equipping the regiments of railway engineers now in France is indicated by the cost of materials ordered up to date, which approximate $70,000,000. The equipment so far ordered includes several hundred locomotives, more than 100,000 tons of rails, more than 3,000 complete turnouts, 500,000 ties, 12,000 freight cars, 600 ballast cars and 600 miles of telephone wire and apparatus, as well as large quantities of construction and repair equipment.

Water Power of Canada.

The water power available in Canada so far as figures can be arrived at, amounts to a possible total of 18,803,000 h.p. of which less than one-tenth has been utilized up to the present.

A Summer and Winter Car

The Pullman Cars of the Freight Train

Roughly speaking, there are two conditions through which perishable freight may be called on to successfully pass through, in order to maintain its marketable value. These are more or less extreme heat and cold. Up to the present time, the railroads in this country have produced a good refrigerator car. It is used to protect perishable products from putrefication in warm or hot weather, but there is no adequate number of cars which will do the opposite, and equally necessary, service of protecting these products from the effects of cold. There are perhaps a number of plausible reasons which may be given for this state of affairs; none of them are cogent and few of them are creditable to the understanding.

Melting ice to keep things cool is practically the opposite of combustion, by which things are made warm. In distant ages, when plant life was luxuriant on this planet, the process of growing was accompanied, or in fact, dependent upon, the giving out of oxygen and the taking in of carbon, in the form of carbonic acid gas. Burning fuel, such as coal and wood, largely consists in re-uniting the previously expelled oxygen and giving out the carbonic acid gas. Now, in the melting of ice we must remember that in the previous production of ice, immense quantities of heat were liberated from the water. This is latent heat or the heat of liquefaction. It must be there in the water or the liquid will become solid. The melting of the ice is accompanied by a heavy drain of heat on all objects surrounding the ice. This is a law of nature and as we are fairly well able to govern the areas of heat abstraction, we get a more or less efficient refrigerator car. An analogous principle is involved in the design of the freight car with a heater.

It has been proposed, and with a great deal of good reason, that the railways, shippers, and producers be encouraged to build and maintain a suitable form of summer and winter car, owned by the railways or as private lines. Such "ideal" cars have been called the Pullman cars of the freight train. The analogy is not merely fanciful. They generally carry the most expensive products. Their contents are vital to a community. Cost mounts up through delay, for the heating or cooling service must go on while the car is loaded. If one may venture to say so the summer and winter car content is the aristocracy of freight shipments.

There is a large supply of Pullman cars in the country, managed by a private company, charging fares sanctioned by the government. In the hot weather when the bulk of passenger travel goes north to the New England States and to the fishing and boating resorts of Canada, this company handles the north-bound traffic by diverting the routes of many of its cars. In the winter when Florida and Southern California claim the tourist and the pleasure seeker, a readjustment of Pullman car routes meets the situation. In like manner a careful regulation of the routes of the "ideal" S and W cars would put things right and keep them so.

It is essential that a winter equipment be independent of the engine. Cars may be held up by breakdowns, by storms, placed on side tracks, stopped by wrecks on the road and for a variety of reasons, which make it necessary to have any heating equipment a separate unit on each car. The heat equipment can be made to cause a circulation of hot air opposite to that brought about by melting ice, and insuring the thorough warming of the floor of the car. This is the area where the ravages of frost first make their appearance in perishable freight, such as fruit, potatoes, and vegetables of all kinds.

The task ahead of us presents no insurmountable obstacles; a great deal of the work required is already done. One thing, however, we must do, and that is to equip each car with some form of good heater, and the alcohol heater on the market today is said to be thoroughly adapted to the requirements of the case: for when once lighted it can run for a week with little or no danger of going out, as the very fuel itself—denatured alcohol—contains in its composition a very large quantity of the oxygen necessary for its own combustion. This heater carries a small supply in bulk, which lasts a very long time and the flame is exceedingly hot. The fuel of this heater is fed automatically and does not require attendants to travel with the cars and it does not bother the train crew. The heaters are outside, so that the loading space in car is not diminished by a stove and fuel box. The chance of stealing is reduced, as there is no excuse to open the cars for the heater, either in real emergency or on alleged necessity. In case the cars pass the international border and go up to Canada, if the heaters were inside, it would be imperative to have a customs officer present when the car was opened, but with outside get-at-able heaters no such restriction can take place.

Another ready-made convenience bearing directly on this matter is available. On any railway of any considerable size, icing stations already exist with a staff of men set apart for the work and with apparatus for accomplishing it. A liquid fuel tank can easily be added beside the existing icehouse, and the same staff of men employed in the summer for icing could handle the heaters in the winter. It would mean steady employment for the men, and by their constant employment they would become proficient, with advantage to the railway.

This extra equipment to cars and fuel stations and this additional service would cost something, though the financial gain to the railway and to the public would soon far outweigh it. As a Pullman passenger is charged extra for superior accommodation, the shipper of perishable freight might reasonably be expected to pay an extra fee for the safe and marketable condition guaranteed by the railway by some such arrangement, and the extra charge could be fixed by law as the price of a sleeper berth is settled by authority.

What we seem to need in this country is not so much permanent government ownership, as we need permanent and expert railway regulation. The British Board of Trade, which is a government department just as much as the Admiralty is, would form a very good model, the scope altered to suit our requirements, yet where all the many and varying questions which come up in railway management might be intelligently handled, not by a mere civilian, unacquainted with work-a-day conditions on the road and in the shop, but by a man or men competent to investigate and to decide. Rate making and tariffs was a good beginning, but we now can profitably extend the scope of railway regulation, not oppressively, but in the line of progressive development. We yet have headlights, signaling, perishable freight, full loads, proper loading methods and a host of transportation problems that require solution, and demand unified authoritative, common sense action, so that the days of papers, academic reports, and records may give place to advantageous performance in the hard, real railway world of today.

Russian Railway Mission Delayed in Japan.

It is officially reported that the Russian railway mission turned back by the Bolsheviki at Vladivostok last December, is being still quartered at Nagasaki, Japan, a large abandoned hotel having been reopened as headquarters for the contingent. The railway corps will remain in Japan until the Russian situation is improved or becomes more definite.

Railway Supply Trade Notes

New Franklin Organization.

The Franklin Railway Supply Company of Canada, Limited, has taken over the business formerly handled by the Montreal branch of the Franklin Railway Supply Company, Inc. The new company will have exclusive rights in Canada to all the products of its parent company and will continue the same policies and business methods that have governed the Franklin Railway Supply Company, Inc., since its formation. The officers of the new company are, J. S. Coffin, chairman of the board; Joel S. Coffin, Jr., president; and Leland Brooks, vice president.

Joel S. Coffin, chairman of the board of directors, brings to the new company a wide and varied knowledge gained from 14 years of railroad work and 26 years in the railroad supply field. He began as a machinist's apprentice and became fireman, engineer and road foreman of engines. Most of his experience was on the Wisconsin Central. He left the railroad to enter the mechanical department of the Galena Signal Oil Company as mechanical expert, was promoted to manager of that department and several years later was elected vice president. After serving as vice president for two years he resigned to accept the vice presidency of the American Brake Shoe and Foundry Company, which position he held until 1911. In 1902 he organized the Franklin Railway Supply Company of which he was president up to 1916, when he was elected chairman of the board. In addition to being chairman of the board of directors of the Franklin Railway Supply Company of Canada, Ltd., and the parent company, Mr. Coffin is a director in a large number of other corporations.

Mr. Joel S. Coffin, Jr., has been elected president of the Franklin Railway Supply Company of Canada, Limited, with offices at Montreal. Mr. Coffin brings to this new organization a wide experience in both the railroad supply business and locomotive building. He was born at Waukesha, Wisconsin, and received his education at the Public Schools in Franklin, Pennsylvania, and Stevens Institute. After leaving Stevens he entered the service of the Venango Manufacturing Company at Franklin, Pennsylvania, and later served the American Locomotive Company in the erecting shop and as Locomotive Inspector.

In 1912 he entered the employ of the Franklin Railway Supply Company as a service representative. He later went into the sales department and in 1915 was appointed Canadian sales manager, which position he held up to the time of his recent election.

Leland Brooks has been elected vice president of the Franklin Railway Supply Company of Canada, Limited, with offices at Montreal. Mr. Brooks was born at New York City and received his education in the public schools at that place and Stevens Institute. Upon leaving Stevens he entered the employ of the New York Central, serving 7 years in the engineering department. Leaving the New York Central he took a position with the Franklin Railway Supply Company, Inc. For the past year he has been connected with their Canadian branch as assistant manager, which position he held up to the time of his recent election.

Seventhly, Here Are Seven Cases.

Seven has always been the number denoting perfection. When the children of Israel marched around Jerico they sounded the trumpets once each day for six days. On the seventh day they sounded the trumpets seven times and the walls of the city fell down, and complete victory was theirs. There were also the seven champions of Christendom that upheld the chivalry of the world in early days. And now in the industrial world and in our own day a champion of another kind appears in the form of the National Tube Company of Pittsburgh,

This concern has just issued a circular in which it gives seven instances of the remarkable ductility of National pipe. One is where it twisted a piece of ¼-inch pipe (7 inches long) 713,000 times and made it look like rubber. Another instance is where gas in a gas well blew off the end cap, but failed to injure anyone of the 26 lengths of National pipe used in the well. The pipe eventually bent into what looked like an enormous whip lash 500 feet long. There are authenticated instances where National pipe stood up to tensile, twisting and common tests, and, seventhly and lastly, this 500 feet of National Tube was racked and forced and pushed and pulled and blown out of an oil well, and was found to be O.K. There's perfection for you. Just count seven, and think of it.

Incorporating a New Company.

The Louisville Frog & Switch Company, Louisville, Ky., has been incorporated with a capital stock of $200,000 to take over the business of the W. M. Mitchell Company, Inc., and to manufacture switches, frogs, crossings and other special track apparatus and fastenings. The officers include W. M. Mitchell, president, and H. O. Wieland, secretary and treasurer. Charles H. Krauss, superintendent of the Weir Frog Company, Cincinnati, Ohio, has resigned to become general superintendent of the Louisville Frog & Switch Company.

Tests on Car Sills and Joists

The U. S. Department of Agriculture has made some practical tests on western yellow pine car sills and joists, for the purpose of getting some knowledge of the mechanical properties of wood. These tests began in 1912 at the Seattle laboratory of the Forest Service. The sills and joists were selected by the representatives of the Forest Service, and they were graded according to the association's export rules for 1911.

The tests resulted as follows:

(1) Car sills and joists representative of the various commercial grades. The car sills were 5 by 8 in. by 16 ft.; and the joists, 2 by 10 in. by 16 ft.

(2) Small, clear pieces cut from the uninjured portions of the tested beams. Tests on these were made to determine the relative strength of wood free from knots and other defects.

The comparatively small number of experiments made on western yellow pine limited the conclusions drawn to the following:

(1) The strength of structural timbers are influenced by the defects found in them. These values vary according to the grades in the green material; but the increase in strength from air seasoning is not uniform and does not vary with the grades.

(2) Seasoning greatly increases the strength of the wood, the increase being greater and more uniform in small, clear sticks than in structural timbers, owing to the development of defects in the latter. Lowering the moisture content of yellow pine causes it to become more brittle.

(3) Western yellow pine is a lighter wood than the other western lumber. The dry weight of clear wood readily suggests its strength or weakness, but this factor alone can not be depended upon to indicate comparative strength when structural forms of various grades are taken into consideration.

(4) In addition to the results of tests on western yellow pine, there are included average values derived from similar tests. It must be remembered that the figures given are averages and that the variability of timber is such that individual specimens of a species may exceed the average of another species. When values from tests of air-dry materials are used for comparison careful attention must be given to the moisture content of the material compared, and the effect of differences of this moisture have to be considered.

Cement for Steam Pipes.

To make a permanent cement used for stopping leaks in steam pipes where caulking or plugging is impossible, mix black oxide of manganese and raw linseed oil, using enough oil with the manganese to bring it to a thick paste; then apply to the pipe or joint at leak. It is best to remove pressure from the pipe and keep it sufficiently warm to absorb the oil from the manganese. In 24 hours the cement will be as hard as the iron pipe.

Items of Personal Interest

Mr. E. M. Lake has been appointed master mechanic of the Meridian & Memphis, with office at Meridian, Miss.

Mr. W. H. Foster, formerly engine despatcher of the Erie at Buffalo, N. Y., has been appointed roundhouse foreman.

Mr. V. N. Potts has been appointed general foreman of the Chicago, Rock Island & Pacific, with office at Liberal, Kans.

Mr. A. B. Beuter has been appointed representative of the Baldwin Locomotive Works at Portland, Ore., succeeding Mr. A. W. Hinger.

Mr. H. Kopper, formerly roundhouse foreman of the Erie at Buffalo, N. Y., has been appointed general foreman of the night force.

Mr. Gorden Patterson, formerly electrician on the Bessemer & Lake Erie at Greenville, Pa., has been appointed assistant foreman electrician.

Mr. Howard H. Kane has been appointed assistant master mechanic of the Texas division of the Gulf Coast Lines, with offices at Kingsville, Tex.

Mr. E. P. McDonald has been appointed assistant master mechanic of the Tucson division of the Southern Pacific, with office at Tucson, Ariz.

Mr. A. Gerrard has been appointed material agent and assistant purchasing agent of the Missouri, Oklahoma & Gulf, with office at Muskogee, Okla.

Mr. Joseph Opia, formerly general foreman of the Chicago, Milwaukee & St. Paul, has been appointed general inspector, with office at Austin, Minn.

Mr. W. P. Murphy and Mr. H. C. McCullough have been appointed road foremen of engines on the Chicago, Rock Island & Pacific, with offices at El Reno, Okla.

Mr. H. Eisele, formerly general foreman of the Wabash at Decatur, Ill., has been appointed shop superintendent at Decatur, succeeding Mr. William Canavan, resigned.

Mr. T. Traccy has been appointed foreman of the machine shop of the Wabash at Decatur, Ill., succeeding Mr. E. J. Wausbach, who has been appointed general foreman.

Mr. E. Hartenstein has been appointed general road foreman of engines on the Chicago & Alton with jurisdiction over the entire system, and headquarters at Bloomington, Ill.

Mr. E. M. Sweetman, formerly master mechanic of the Southern, with office at Spencer, N. C., has been transferred to a similar position at Knoxville, Tenn., succeeding Mr. N. N. Boyden.

Mr. W. D. Hitchcock, formerly foreman on the Santa Fe, at Los Angeles, Cal., has been appointed master mechanic at Winslow, Ariz., succeeding Mr. M. Weber, transferred to San Bernardino, Cal.

Mr. W. W. Lemen has been appointed superintendent of the motive power and car departments of the Denver & Rio Grande, with office at Denver, Colo., succeeding Mr. W. J. Bennett.

Mr. J. C. Woods has been appointed acting master mechanic of the Quincy, Omaha & Kansas City, and the Iowa & St. Louis, with office at Milan, Mo., succeeding Mr. C. H. Montague.

Mr. George W. Ray, formerly employed in the Frisco system at St. Louis, Mo., has been appointed general roundhouse foreman at the Brighton Park Roundhouse of the Chicago & Alton.

Mr. J. H. Edwards, formerly foreman electrician at the Silvis shops of the Chicago, Rock Island & Pacific at Rock Island, Ill., has been appointed supervisor of stationary plants.

Mr. N. C. Kieffer has been appointed fuel agent of the Southern railway lines west, with headquarters at Cincinnati, Ohio, succeeding Mr. R. D. Quickel, who has entered military service.

Mr. George Kuhns, formerly superintendent of equipment of the International Railway Company, of Buffalo, N. Y., has been transferred to the position of master mechanic, a place formerly held by him.

Mr. W. B. Steeves, formerly locomotive foreman of the Canadian Northern, with office at Saskatoon, Sask., has been appointed master mechanic of the western district with office at Edmonton, Alta.

Mr. R. P. Lamont, president of the American Steel Foundries, with office at Chicago, has been appointed a lieutenant-colonel and assistant chief of the procurement division of the Ordnance Department.

Mr. C. J. Wittel has been appointed roundhouse foreman of the Chicago, Rock Island & Pacific, with office at Herington, Kan., and Mr. H. F. Merchant has been appointed roundhouse foreman at El Reno, Okla.

Mr. E. W. Harvey has been appointed division master mechanic of the Illinois and Racine and Southwestern division of the Chicago, Milwaukee & St. Paul, and the Rochelle & Southern lines, with office at Savanna, Ill.

Mr. Joseph Rodenberger, formerly traveling engineer of the Chicago, Milwaukee & St. Paul, has been appointed division master mechanic of the Hastings and Dakota divisions of the same road, with office at Aberdeen, S. D.

Mr. James Gunther, formerly engine inspector on the Santa Fe at Topeka, Kans., has been appointed to a similar position by the Interstate Commerce Commission at Kansas City. Mr. Ross Rader succeeds him at Topeka.

Mr. Waldo H. Marshall, formerly president of the American Locomotive Company, and now associated with J. P. Morgan & Co., has been appointed assistant chief of the Division of Production of the Ordnance Department.

Mr. F. O. Walsh, superintendent of motive power of the Georgia, has been appointed superintendent of motive power and equipment also of the Atlanta & West Point, and the Western Railway of Alabama, with office at Montgomery, Ala.

Mr. J. H. Elliott, formerly general manager of the Texas & Pacific, with headquarters at Dallas, Tex., has accepted the appointment as assistant general manager of the railways of the American expeditionary forces in France.

Mr. L. H. McDaniel, formerly master mechanic of the Nashville, Chattanooga & St. Louis, at Paducah, Ky., has been transferred to Chattanooga, Tenn., and Mr. D. T. Lucas, formerly master mechanic at Chattanooga, has been transferred to Paducah.

Mr. J. F. Gildea, formerly division master mechanic of the Canadian Pacific, with office at Montreal, Quebec, has been appointed master mechanic of the Pennsylvania division of the Delaware & Hudson, with office at Carbondale, Pa., succeeding Mr. J. J. Reid, resigned.

Mr. W. F. Kuhlke, formerly assistant trainmaster of the Charleston & Western Carolina, has been appointed superintendent of motive power. The position of master mechanic at Augusta, Ga., made vacant by the death of Mr. T. B. Irvin, has been abolished.

Mr. J. L. Donnelly has been appointed roundhouse foreman of the Chicago, Milwaukee & St. Paul, with office at McGregor, Ia. Mr. George Fenner has been appointed to a similar position at Manilla, Ia., succeeding Mr. J. H. Bell, transferred to Dubuque, Ia.

Mr. H. H. Carrick, formerly assistant master mechanic of the Southern Pacific at San Francisco, Cal., has been appointed master mechanic of the Stockton division, succeeding Mr. F. P. McDonald, transferred, and Mr. J. T. Slavin has been appointed master mechanic of the coast division with office at San Francisco, succeeding Mr. Carrick.

Mr. P. J. Kearney, formerly electrical engineer of the New York, New Haven & Hartford, at New Haven, Conn., has resigned to join the Ordnance Department at Washington. Mr. Kearney is a graduate of the Massachusetts Institute of Technology, and entered the service of the New York, New Haven & Hart-

ford in 1906 as assistant to the electrical engineer.

Mr. W. H. Erskine, formerly master mechanic of the Great Western at Des Moines, Ia., has been appointed master mechanic of the Virginian, and Mr. Frank Aitken, formerly master mechanic of the Pere Marquette at Wyoming, Mich., has been appointed master mechanic of the Chicago Great Western, succeeding Mr. Erskine at Des Moines.

Mr. F. W. Schultz, master mechanic of the Kansas City, Mexico & Orient, has his jurisdiction extended over the entire system, with offices at Wichita, Kans., and San Angelo, Tex., and the office of superintendent of motive power and car departments is abolished, the duties appertaining to the same being assumed by Mr. Schultz.

Mr. G. A. DeHaseth, formerly chief engineer of the Tacoma Railway & Power Company, and chief engineer and roadmaster of the Puget Sound Electric Railway, of Tacoma, Wash., has been appointed manager of the Ponce Railway & Light Company, of Ponce, Puerto Rico, to succeed Mr. P. M. Hatch, who is now in the service of the government.

Mr. J. M. Kerwin, master mechanic of the Chicago, Rock Island & Pacific, formerly with office at Estherville, Ia., has been transferred to newly opened headquarters at Silvis, Ill., and Mr. R. J. McQuade, formerly general foreman of the locomotive department at Chicago, Ill., has been appointed master mechanic to succeed Mr. Kerwin at Estherville.

Mr. C. C. Smith, formerly president of the Union Steel Casting Company, Pittsburgh, Pa., has been elected chairman of the board of directors of the company. Mr. J. P. Allen, formerly vice-president, has been elected president; Mr. S. H. Church, vice-president; Mr. G. W. Eisenbeis, treasruer; Mr. W. C. Eichenlaub, secretary, and Mr. J. B. Henry, general superintendent.

Mr. J. H. Hackenburg, formerly assistant purchasing agent of the Pressed Steel Car Company, Pittsburgh, Pa., has been appointed purchasing agent. Mr. H. B. Fisher and Mr. C. C. Clark have been appointed assistant purchasing agents; Mr. W. C. Howe, formerly in charge of the Allegheny plant, has been appointed assistant to the vice-president, and Mr. J. C. Ritchey has been appointed electrical engineer.

Mr. W. H. Lovekin has been appointed assistant to the president of the Locomotive Feed Water Heater Company. Mr. Lovekin is from Philadelphia, and is a graduate of Princeton University. He was engaged for some time in the Bureau of Municipal Research in Philadelphia, and latterly entered the sales department of R. J. Crozier & Co., of Philadelphia, and has a wide experience among railroad men. In June, 1916, he entered the service of the Locomotive Feed Water Heater Company as special representative. In April, 1917, he was appointed assistant to the vice-president, which position he held at the time of his appointment as above.

W. H. LOVEKIN.

Mr. Guy E. Tripp, formerly chairman of the Westinghouse Electric and Manufacturing Company, has been appointed by the War Department as chief of the production division of the Ordnance Department, intrusted with the task of

GUY E. TRIPP.

supervising and stimulating the production of all ordnance supplies. Mr. Tripp was selected because of his experience in the manufacture of munitions of all kinds, the Westinghouse Company having obtained large contracts from the British and Russian Governments immediately on the outbreak of the European war. Mr. Tripp will give a good account of himself.

Report of the American Locomotive Company.

The semi-annual report of the American Locomotive Company for the six months ending December 31, 1917, was issued last month, and presents a very gratifying condition of the company's vast industries. The locomotive output has all been obtained from the Schenectady, Brooks, Pittsburgh and Cooke plants. The Montreal and Richmond plants had been occupied on munitions work for nearly two years, but their contracts were completed last August, and these are again completely refitted for locomotive work. The investments have nearly trebled in three years. A satisfactory adjustment has been made in regard to 250 locomotives ordered by the Russian Government in 1917, the United States Government aiding in the settlement of the matter. The work for the current year has begun under the most favorable conditions.

Car Foremen's Association of Chicago.

The official proceedings of the Car Foremen's Association of Chicago were interestingly diversified at last month's meeting by the introduction of a series of pictures furnished by the National Tube Company. The members were much interested in seeing how iron pipe was really made. The pictures showed the ore being taken from the mine; they showed it being converted into molten steel; they showed the steel being poured into ingot molds; they showed the ingots being rolled out to the proper size and then the bar bent round, the steel reheated to welding heat and welded as it passed through the rollers. The pictures also showed the different methods of testing pipe, and inspecting to see that only perfect pipe was put on the market. In fact one could read books and magazines for a week and not get as much vital knowledge of how iron pipe was really made as was obtained in one hour looking at the moving pictures.

Metal & Thermit Corporation.

The Goldschmidt Thermit Company and the Goldschmidt Detinning Company will hereafter be conducted by the Metal & Thermit Corporation, with main offices at 120 Broadway, New York. The combinations which are exclusively controlled by Americans, are now placed under joint management, and it is gratifying to observe that extensive arrangements are being made to meet the rapidly growing demand for the company's products. The following are the officers and directors: W. T. Graham, Edgar L. Marston, Daniel G. Reid, F. S. Wheeler, Hubert E. Rogers, F. H. Hirschland, E. L. Ballard, L. A. Welles, Charles F. Dane, Philipp Gensheimer and Fred W. Cohen.

Railroad Equipment Notes

The Philadelphia & Reading proposes to build 15 locomotives in its shops at Reading, Pa.

The Kansas City Structural Steel Company, Kansas City, Mo., is building 100 10,000-gal. tank cars.

The Chicago & North Western will build a new engine house and repair shop at Montfort, Wis.

The Delaware & Hudson has ordered 20 Consolidation locomotives from the American Locomotive Company.

The Missouri, Kansas & Texas has ordered 20 freight locomotives from the American Locomotive Company.

The Delaware, Lackawanna & Western has ordered 15 Mikado engines from the American Locomotive Company.

The Portland Terminal has ordered two six-wheel switching locomotives from the American Locomotive Company.

The Minneapolis & St. Louis has ordered five Pacific and 15 Mikado locomotives from the American Locomotive Company.

The Maine Central has ordered eight ten-wheel and four six-wheel switching locomotives from the American Locomotive Company.

The Minneapolis & St. Louis has ordered 15 Mikado and five Pacific type locomotives from the American Locomotive Company.

The Long Island is reported as ordering four 101-ton eight-wheel switching locomotives from the American Locomotive Company.

The Atlantic Coast Line is reported as having ordered 1,000 40-ton steel underframe ventilator cars from the Standard Steel Car Company.

The Pennsylvania has ordered from the General Railway Signal Company material for an eight-lever Saxby & Farmer interlocking machine at Cresson, Pa.

The Chicago & Eastern Illinois is rebuilding its machine shop and engine house at Salem, Ill., recently damaged by fire. The new structure will cost $300,000.

The Miami Conservancy District, Ohio, has ordered three 48-ton and 10 38-ton four-wheel saddle tank switching locomotives from the American Locomotive Company.

The American Car & Foundry Company has received an order from the Ordnance Department, United States Government, for 150 30-ton steel underframe ammunition cars.

The Hocking Valley has ordered 20 2-6-6-2 Mallet type locomotives from the American Locomotive Company. The locomotives will weight 437,000 lbs., and will be equipped with superheaters.

The Pacific Electric, Los Angeles, is having plans prepared for the erection of 14 new shop buildings at its works at Torrance, including machine shops and forge works. The total cost is estimated at $1,000,000.

The Central of Georgia has ordered three Mountain and 10 Mallet type locomotives from the American Locomotive Company. The Mountain type locomotives will weigh 318,000 lbs., and the Mallet locomotives 440,000 lbs.

The Chesapeake & Ohio has ordered 15 2-6-6-2 Mallet and 10 ten-wheel switching locomotives from the American Locomotive Company. The Mallet type locomotives will weigh 437,000 lbs., the switching locomotives 295,000 lbs., and all will be equipped with superheaters.

The Missouri, Kansas & Texas, reported as having ordered 20 freight locomotives from the American Locomotive Company has ordered 25 locomotives. The locomotives will be of the Mikado type and will be superheated and weigh 314,000 lbs.

The Wisconsin & Michigan has purchased a tract of nine acres in Menominee, Mich., and will build new shops, engine house, etc. An ore dock will be built on the site of a former steamship dock, which will provide adequate facilities without considerable dredging being required.

The Pennsylvania Lines West of Pittsburgh will have mechanical interlocking on the new drawbridge at Louisville; a Saxby & Farmer machine with 30 working levers and six spare spaces. The contract for the material and for installation has been given to the General Railway Signal Company.

The Lenoir Car Works, Lenoir City, Tenn., plans to rebuild along larger and more modern lines its blacksmith and machine shop, totally destroyed by fire recently. The engineering and building will be done by its own organization, and it does not contemplate any radical changes

other than the installation of an overhead crane.

The Philadelphia & Reading has let a contract for erecting a machine shop at Philadelphia to be 216 feet long, 130 feet wide at one end and 156.6 feet at the other; also a large engine house with 10 stalls 90 feet long and six stalls 110 feet long. The improvements will cost about $326,183.

Specifications have recently been determined on orders received by the American Locomotive Company some months ago for the following locomotives: Central of Georgia, three mountain type locomotives weighing 318,000 pounds and ten Mallet locomotives weighing 440,000 pounds; Missouri, Kansas & Texas, 25 Mikado locomotives weighing 314,000 pounds.

Word from Washington announces that the United States Government order for freight cars for France has been distributed among the car manufacturers as follows: American Car Foundry Company, 950; Pullman Company, 500; Standard Steel Car Company, 950; Mt. Vernon Car Manufacturing Company, 260; Cambria Steel Company, 500; St. Louis Car Company, 100; Haskell & Barker, 500, and the Pressed Steel Car Company, 500.

The Lake Superior & Ishpeming, and the Munising, Marquette & Southeastern railroads will shortly begin construction of new shops, at the ore docks of the former road, to cost $425,000, and to include an engine house, with boiler room, an 80-foot steel turn table, a machine and work shop 115 by 143 feet, blacksmith shop 42 by 82 feet, oil house, coaling station, car repair shop, steel shop 21 by 41 feet and other buildings.

Rustless Steel.

Some years ago a firm in Sheffield, Eng., brought out a process by which steel is made non-rusting, unstainable, and untarnishable. This steel is said to be especially adaptable for table cutlery, as the original polish is maintained after use, even when brought in contact with the most acid foods, and it requires only ordinary washing to cleanse.

"It is claimed," writes Mr. Savage, U. S. Consul General at Sheffield, in the commerce reports, "that this steel retains a keen edge. Knives can readily be sharpened on a 'steel' or by using the ordinary cleaning machine or knifeboard. It is expected it will prove a great boon, especially to large users of cutlery, such as hotels, steamships, and restaurants and railway dining cars. It is considered that the saving of labor will more than cover the increased cost of the cutlery in the first year."

These two processes are probably not the same, for the method used with the cutlery has not been made public as the other has, though the satisfaction with knives, etc., so treated is now beyond question. The constant, dilligent endeavor to obtain a rustless steel, which can be used where great areas are concerned, is some day likely to be rewarded by complete success.

Use of the Locomotive Whistle

Superintendent T. Ahern, of the Coast division of the Southern Pacific in a letter to the engineers, says: "Extensive tests show that a whistle call for a station signal should never be less than five seconds, the long blasts of the crossing signal two and a half seconds and the short ones one second. Particular care should be exercised to cut off the blasts sharply and not to slur them. It is of the utmost importance in causing sound to travel that these instructions be carried out. After sounding a whistle cut off the steam completely and allow a perceptible time to elapse between the blasts. They then are carried to a distance very much more clearly than if jumbled into one continuous blast. The whistle is an important safety device, of which we must make efficient use."

New York Railroad Club.

At the regular monthly meeting of the New York Railroad Club, held on February 15, a technical paper on the subject of the "Dynamic Augment—Need and Means of Reducing It," was presented by Mr. E. W. Strong of the American Vanadium Co., Pittsburgh, Pa. The paper contained much valuable data on the effect of the increased weight of the reciprocating parts of locomotives and the difficulty of counterbalancing the parts, and dwelt with convincing logic on the fact that in this age of heat-treated and alloy steels the designer has exceptional opportunities for reducing the weight of the parts. By using hollow bored crank pins and piston rods, rolled steel or alloy and special cast steel pistons; and by special care in the design of all details, a large percentage of saving can be effected in the weights of reciprocating parts.

Drilling Hard Steel.

A mixture which will permit hard steel or iron to be drilled with ordinary drills is made by using one part spirits of camphor and four parts turpentine. Mix well and apply cold, letting it remain a few minutes before applying the drill. Run the drill slowly with fine feed.

Books, Bulletins, Catalogues, Etc.

Baldwin Record No. 89.

The Baldwin Locomotive Works Bulletin No. 89 consists of an unusually interesting, illustrated historical essay, by J. Snowden Bell, on "The Development of the Eight Driving Wheel Locomotive." The author traces the gradual growth and development of this type of locomotive from that used at the Wylam Colliery Railroad in 1825, and which had the peculiarity of being equipped with intermediate spur wheels for conveying the motion from the main driving spur wheel to the other wheels, along to the powerful types of our own day. There are fifteen illustrations used in tracing the gradual increase in size and variation in construction showing the numerous improvements in structural features and accessories which have been embodied in locomotives of the various other designs that have, from time to time, been introduced. Mr. Bell is of the opinion that the advantage of the design, as practically perfected in the improved types in which it has been applied, is unquestionable, and other than for exceptional conditions of service it will doubtless continue to be the preferred one for freight train work.

Wilson Welding Metals

As is well known in the earlier application of electric welding attention was directed solely to developing the machines employed in the operation, and not as much to the welding itself as should have been. In the Wilson system of welding, care has been taken to provide metals that are not adversely affected by the heat of the arc. The latest and most successful development consists of a manganese copper alloy used as an electrode forming an arc, and which combines an excess of manganese and copper over the amount burned out in the arc as will retain in the welded joint an additional degree of toughness and ductility due to said excess. This alloy has been developed to the highest point of efficiency through the extended services of some of the best metallurgists in America, and no other system of welding can use these metals.

Lubrication.

Last month's *Lubrication* contains an able article on the subject of "Forced Lubrication," by Lieut. Commander A. T. Church, U. S. N., wherein he advocates the necessity of keeping a careful watch on the temperature of the main bearings and thrust bearings. Conditions in forced lubrication systems are quite different from those in sight or wick-feed systems. Since the oil is used over and over again, any that may be squeezed out from between the bearing surfaces does not represent a loss; also the oil can be supplied in any amount, thereby eliminating the possibility of an insufficient supply to the bearings. Therefore a lighter oil may be used than with the wick-feed. Every effort should be made to exclude water, since the oil must be kept in continuous circulation, and the effect of a water leak soon becomes cumulative. One of the primary requisites of a forced-feed oil is that it must not saponify and must separate readily from water. Too much care cannot be exercised to keep the oil clean and free from the least grit that excessive wear of bearings may be avoided.

Unraveling the Tangle.

Mr. Theodore P. Shonts, president of the Interborough Rapid Transit Company, delivered an address last month before the Detroit Board of Commerce on "How the Railroad Tangle May Be Unraveled." Mr. Shonts claims that as a possible solution of the national problem with which our country is struggling—Shall we return to old railroad conditions after the war?—"I suggest a partnership between the Government and the railroads, something like the partnership that has been formed in New York by the city and the rapid transit lines for the construction and operation of the city's new dual rapid transit system.

The interests of the country, with its need for greatly enlarged and extended railroad facilities, and the interests of investors are so interwoven that the financial responsibility should likewise be interwoven. This doctrine underlies the principles embodied in the contract for New York's new and dual rapid transit system, probably the first place such a plan has been attempted with any degree of magnitude."

The Railroads and Politics

The *American Industry in War Time* for February says that the railroads cannot be divorced from politics under Government control, and the only hope is that they will not be injected into the next Presidential campaign in such a way as to wreck them physically and financially. There is a grave danger that politics may complicate our transportation problem. The American people should understand how intimately related Governmental control of the railroads is to the next Presidential election, and they should insist that their Representatives and Senators make the time for turning back the roads to the stockholders as short as possible consistent with the work which will have to be done at the close of the war.

Graphite.

The lively organ of the Joseph Dixon Crucible Company, Jersey City, N. J., has always, apart from the interesting descriptions of its substantial products, something in keeping with the spirit of the strenuous days in which we live. Last month's issue has an excellent article on "Low Visibility Paints," which clearly points out the advisability of low visibility either internally or externally. Blending with the horizon seems to be the dominant note. Its efficacy has been discovered and utilized in the army and navy. Art may surpass nature in many things, but it cannot surpass it in color. Dixon's Silica-Graphite paint has two colors that give low visibility. These are Dixon's natural color and olive green. They have been tried and may be said to defy the elements—at least for a long time.

The Collapse of Tubes.

Bulletin No. 99, issued by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., furnishes a mass of interesting data on the collapse of tubes, with formulae for ascertaining the collapsible pressures, and examples of the various forms assumed by the various lengths of tubes. Illustrations of the apparatus used in the experiments and diagrams of results are furnished. Eminent authorities are quoted and compared, and the data may be said to be the very latest in the testing of tubes. Copies of the Bulletin may be had on application to the University. Price, 20 cents.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXI | 114 Liberty Street, New York, April, 1918 | No. 4

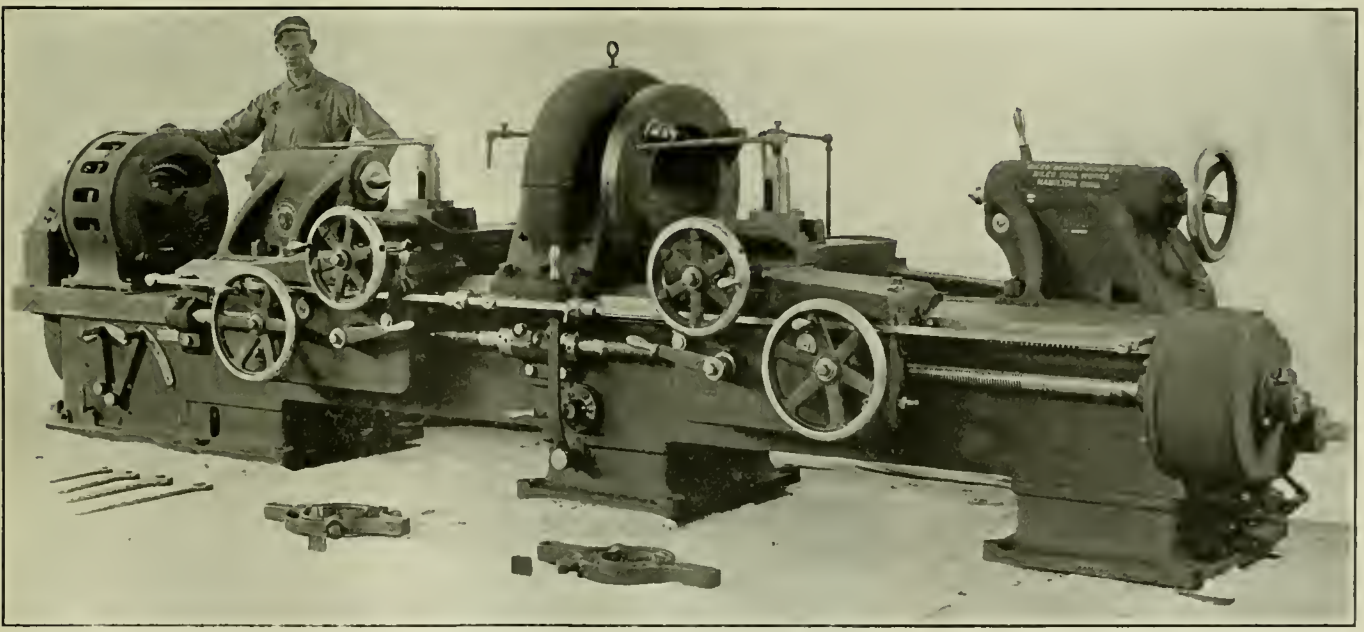
New Design of High-Power Double-Acting Lathe Adapted for Machining Axle Forgings

Our frontispiece illustration shows a new design of high-power double-acting lathe, known as No. 3 Axle Lathe, that has been recently placed on the market by the Niles-Bement-Pond Company, New York, and is a high production machine of heavy construction throughout, and is designed for machining axle forgings as well as rough machined axles. It is center driven and adapted for turning wheel seats and journals simultaneously at both ends of car axles.

As constructed for constant speed motor drive for alternating current, the motor is mounted on a speed box at the left hand end of the bed as shown on the frontispiece. Power is transmitted by gearing from the speed box to the driving shaft, giving four speed changes to the driving head, ranging from 16 to 48 revolutions per minute. The speed box gears are of steel and run in oil, all bearings being automatically lubricated. For starting and stopping the machine a friction clutch is provided, the clutch being mounted within the speed box driving gear. In the case of the lathe being adapted for an adjustable speed motor drive for direct current, the motor of 3 to 1 speed variation is mounted on a base plate attached to the left hand end of the bed. The motor is geared directly to the driving shaft.

The bed is of very rigid construction and is reinforced by cross-girts of box section 8 ins. wide. The tracks for the carriage consist of a wide flat way at the back of the bed and a track of an improved compensating "V"-shape at the front. This improved "V"-shape track has an angle of 15 degs. at the back and an angle of 70 degs. at the front. This feature is shown in the end view of the lathe. The 15-deg. angle on the back of the "V", serves a double purpose; it prevents a thrust-surface at right angles to the combined forces of the tools, eliminating all tendency of the carriages to climb under heavy cuts, and it automatically compensates for wear of both the carriages and the bed.

The center driving head is of massive construction, completely enclosing the main driving gear and forms an oil reservoir in which the gear runs. It is clamped to the bed by six large bolts, and is adjustable longitudinally along the bed. The main drive is by means of large steel herringbone type gear and pinion which are carried between bearings in the head. These bearings are of large proportions, and special provision is made for a liberal supply of oil. Because of the spiral action of the teeth, the herringbone gear provides a smooth, powerful drive, and all objectionable noise is eliminated when running at high velocity. The axle is driven by a steel equalizing driving plate, having lugs cast integral which engage both ends of the double driver dog. By means of this driving plate, crooked or irregular axles can be



NILES-BEMENT-POND COMPANY'S NO. 3 AXLE LATHE.

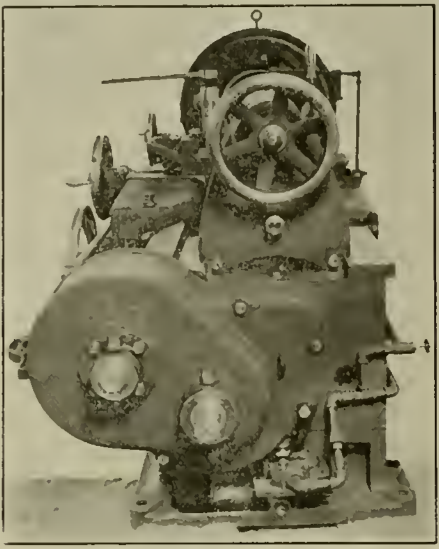
machined without setting up bending strains.

Two carriages are provided which have power longitudinal feeds by a right and left hand screw positively driven by gearing. The split nuts engaging the lead-screw are provided with automatic opening devices which release them when the carriages come in contact with set collars on the tappet rod at the front of the machine. The carriages are laid down by clamps for their full length and are adjustable to the front and back vertical surfaces of the bed by taper gibs. Two clamps are provided at the front of the carriages. One of these is used for clamping the carriage to the bed when turning against shoulders and facing ends of axles. This clamp is operated by a bolt on the top of the cariage. The other clamp is under the bridge and further decreases the tendency of the carriage to lift during the burnishing operation.

Wipers are attached to both carriages, to remove all chips and dirt from the shears. They are fitted with felt pads and provide the surfaces with a continuous supply of clean lubricant. A complete lubricating system for the tools is provided by means of a pump, jet pipes, reservoir and collecting channels. The tool slides are provided with a trough which is connected with channels in the carriage bridge for carrying off the lubricant. The aprons are of double wall construction and all of the mechanism except the operating levers, is completely enclosed. All shafts are supported at both ends.

The feed gears are located at the right-hand end of the bed and are completely enclosed. The feed change lever is placed at the center of the machine within easy reach of the operator. These feeds are provided for the carriages,—1/16-in., 3/32-in., and 3/16-in. The carriages have a hand traverse on the bed and tool slides have hand cross feed. The axle is carried on dead centers mounted on two heavy tailstocks which are adjustable longitudinally along the bed and each is clamped in position by four large anchor bolts. To prevent slipping, a pawl is provided which engages a rack cast in the bed. The tailstocks have taper gibs at the front and back of the bed, permitting alignment of spindles. The spindle of the right-hand tailstock is adjustable by hand-wheel.

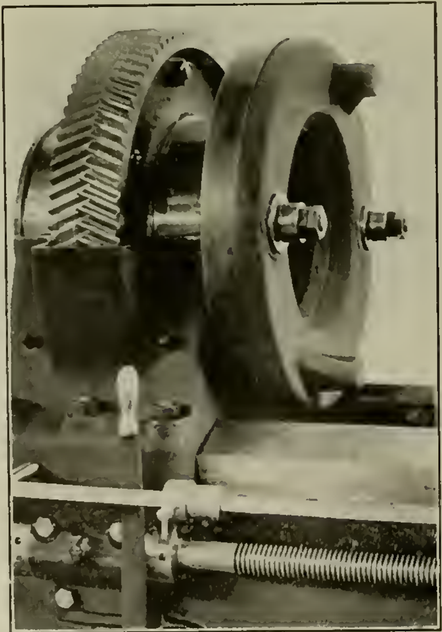
The lathe is also constructed for a cone-pulley drive, with a 3-step cone having a maximum diameter of 32 ins. for a 7-ins. belt. A two-speed countershaft is provided, giving six speeds to the driving head ranging from 16 to 48 revolutions per minute. The single pulley drive design is driven by a single pulley 26 ins. diameter for an 8-ins. belt, driving through a speed box mounted at the left-hand end of the bed. The speed box transmits four speed changes to the driving head, ranging from 16 to 48 revolutions per minute. For starting and stopping the machine a friction clutch is provided. This clutch is mounted within the driving pulley and is operated by a lever conveniently located at the center



END VIEW SHOWING CROSS SECTION OF IMPROVED "V" TRACK.

of the machine. When the clutch is disengaged a brake is automatically applied, bringing the machine to a quick stop.

A crane for handling axles in and out of the lathe may also be furnished. The crane has a very convenient gripping de-



HERRINGBONE DRIVING GEAR.

vice and hoist that can be easily handled by one man.

The following are some of the general dimensions of the lathe: Length of bed 14 ft., width at shears, 27½ ins.; diameter of spindles, 5 ins.; traverse of right-hand spindle, 9 ins.; left-hand spindle, stationary; length, constant speed motor drive, 18 ft. 9 ins.; width, 4 ft. 3 ins.; height, 5 ft.; length, adjustable speed motor drive, 19 ft. 1 in.; width, 4 ft.; height, 5 ft.; cone pulley drive, length, 17 ft. 2 ins.; width, 4 ft. 8 ins.; height, 5 ft.

Open Letter to the Hon. The Director General of Railroads.

Competing Appliances and Standardization

The following letter has been addressed by the President of the Railway Business Association to the Director General of Railroads advocating the continued use, during the war, of established competing devices on engines and cars. The letter is as follows:

To the Hon. William G. McAdoo.
Director General of Railroads,
Washington, D. C.

Sir:

Manufacturers of railway necessaries respectfully invite you to study certain considerations bearing upon mechanical design and practice in the field of rolling stock construction, purchase and maintenance.

The Railway Business Association, of which I have the honor to be President, is a national organization of manufacturers, merchants and engineers dealing with steam railroads. What we have to say from our own experience accurately portrays the problems of the whole railway appliance industry.

It appears from your official announcement that you have delegated to technical committees the work of recommending to you a detailed plan of procedure for the acquirement of new rolling stock by the railroad systems. The phases upon which we desire to address you are those which involve the peculiar interest of makers of appliances or parts as distinguished from assemblers of locomotives and cars.

In the field of transportation inventors and developers of special appliances embody the spirit and function of progress. Our interest and the national interest in this respect are identical. What the manufacturers of railway appliances cherish and what the public as a whole is interested in preserving is that flexibility which leaves the way open to mechanical advance. Always we have before us two antagonistic requirements which must be compromised—improvement through some change and stability through standardization.

To a certain extent standardization is essential. As transportation became national and interchange of cars among the several roads became common, convenience and economy in repairs required a tendency toward interchangeability of parts. With the organization of the Railroads' War Board last April came for the first time to any extent use of engines on

the rails of roads other than the owner. What has long applied to cars affecting repairs now applies in some degree to engines. The drift, as with cars is toward interchangeability of parts. The method by which inter-line use of cars was made possible was, to be sure, standardization, but it was a standardization of dimensions. If the car frame were uniform a device of any patent could be used upon it. Thus we attained practical current convenience while preserving variety of design and material, of terms, delivery and dealings, and hence reasonable expedition in the demonstration and introduction of improvements.

We earnestly commend to your favorable consideration the fullest adherence to this method consistent with the most effective rehabilitation and maintenance of transportation facilities in face of the enemy. We are ready for any sacrifice essential to winning the war. We would deplore as disastrous to the nation's business any departure, not clearly necessary for national defense, from competition between patented railway appliances.

Manufacturers of railway goods have borne an honorable part in promoting the progress of transportation science. What they have achieved for the public in safety, comfort, speed and economy of railway operation has been accomplished in an atmosphere of keenest competition. We could try persuasion upon one independent railway manager after another until the test was made and a demonstration afforded. Our work has been marked by variety, elasticity, development. The inventor, the executive and the salesman have been inspired by the hope of excelling, roused to effort by the exertions of rivals. Under such conditions our industries and the country with them have progressed and thriven. The man with whom we have hitherto dealt has had a definite responsibility for affording his company the benefit of the latest scientific discoveries.

We believe that the preservation of decentralization in our dealings is not only important for the immediate present, but vital as a precedent for the ultimate adjustment after the war.

Looking especially to the present, many of those engaged in the railway supply industry are profoundly anxious concerning the policy which you will adopt as it may affect them and the scores of thousands of workers whom they employ.

Unofficial statements and rumors have hinted at the possibility of far-reaching standardization, under which large numbers of plants would be swept out of existence or forced to reorganize for some other type of service. A maker produces, let us say, a device which is part of a car. He is one of several who manufacture competing appliances that perform the same function. Will some one of us, he has been asking, be declared standard and all the others thrown into the discard? If so, the conclusion of peace would find the unfortunates whose products had been discarded under the edict of standardization for the period of the war deprived of a large part of the value of their patents through disuse and their business paralyzed through discontinuance of the mechanical and commercial processes which keep any business a progressive living organism.

Established commercial processes are the result of experience and of scrutiny under government regulation, federal and state. We are confident that you will be alert to the desirability of performing your difficult and vital function as Director General of Railroads with the least possible disturbance to these processes. We believe that you will find it practicable to preserve the business and the individuality of the several makers of rolling stock appliances. Cars have now been so far standardized in dimensions that they can travel over any railroad in the United States, as anyone can see who observes upon a freight train the multiplicity of ownership insignia. So far as speed of production is concerned little or no delay is occasioned in changing from one patent to another and substituting on each lot the appliances which have been designated by the particular buyer.

We can see no obstacle to the adoption of a plan under which, whatever the design of the car as a whole, every reputable established appliance for each function would be sanctioned and the several roads directed to exercise, as in the past, their judgment in specifying devices.

What applies to construction of new rolling stock is of more importance in the field of maintaining rolling stock that exists. The largest number of locomotives ever ordered for domestic account in any one year was 6,265. The number of locomotives in use and under maintenance according to the last report was 63,862. The largest number of freight cars ever ordered in any one year was 341,315. The number of freight cars in existence and requiring upkeep as last reported was 2,326,987. Obviously the big end of the rolling stock task and the preponderant consumption of engine and car parts is not in new construction but in maintenance. Apart from repairs made by one railroad upon cars found out of order on its rails a highly important proportion of such work is the thorough overhauling of cars by the road that owns them in its own shops. For replacement of parts broken or worn out each road orders from the makers quantities of whatever appliances are standard upon that road. Stability in the industry during the war will be promoted by permitting in general each road to determine as in the past which of the competing appliances it will use in repairs.

Such a policy, affecting both construction and repair upkeep, will not only give rapidity and certainty to the exigent performance in war and preserve for the time of peace the commercial organizations which have carried on mechanical progress, but it will involve the minimum readjustment of shop operation and production quotas, thus keeping these enterprises in a strong position as payers of war taxes and subscribers to war bonds—these and the tradesmen and the people of the communities wherein their plants are located who draw sustenance primarily from the industrial pay roll.

Please permit me personally, and I believe I may say the same thing in my representative capacity, to felicitate you, Sir, upon your manifest determination to form judgments based upon knowledge and upon the opinion of those whose vocation fits them to serve the country through you at this crisis.

Geo. A. Post, *President*,
Ry. Business Assn.

Reclaiming Waste.

A correspondent in the Practical Engineer states that the high cost of waste and rags used throughout the machine shop makes it necessary to cast about for means to reduce our charges for this material, so we devised a washing arrangement, which was made up by our engineer out of some old pipe fittings. A piece of 12-in. pipe was arranged with companion flanges on each end, a steam inlet in the side, and a drain at the bottom. A screen was then placed in the pipe about 4 ins. above the steam inlet. The oily waste was placed in the washer above the screen by removing the companion flange, and then the whole mass was boiled by turning in the live steam, the condensation dripping down through the waste and carrying the oil and dirt off through the blow-off valve. While this crude washing did not turn out perfectly clean waste, it, nevertheless, took out such a large percentage of the oil, grit and dirt that the waste could be used for practically all purposes. The expenditure for new waste was thereby cut down by one-half and one-third each month.

Railroad Gardening.

A garden at every section-house is one of the food-producing measures which the Southern Pacific are putting into effect this season. Agents, section foremen and trackmen, from Portland to El Paso and San Francisco to Ogden, are being instructed to convert to vegetable gardens all suitable ground available. In addition, the company is endeavoring to lease all cultivable land which it owns (not used by employees) and a good deal of the right-of-way land adapted to truck gardening or agriculture, is being leased. Vegetable gardens were made last year by hundreds of employees with great success.

Norfolk & Western Composite and All Wood Cars

Details of Gondola and Box Cars—Great Saving of Steel—Unique Method of Framing and Other New Features—Equipped with Farlow Draft Gear

The Norfolk & Western Railway have recently built some gondola and box cars of wood, owing to the difficulty of getting steel. In doing this the N. & W. have met an existing condition in a common sense way. After all, that is one of the fundamental principles of organic evolution. A plant living by wet land, suddenly finding that the water has dried up or receded a long distance from it, is compelled to produce a thick, bulbous, water-retaining stem, or it will die. In doing this, the plant successfully meets a new condition, that is all. Some are inclined to think that in this age of steel, reverting to wooden construction is a backward step. As a matter of fact it is an evolutionary step forward, and the N. & W. deserves to be commended for its action.

W. H. Lewis, S. M. P. NORFOLK & WESTERN ALL-WOOD CAR Builders Norfolk & Western

This railway has built 2,000 hopper cars with a capacity of 57½ tons each, and out of the 2,000 at least 1,990 cars have steel centre sills and steel bolsters. Ten cars have been built of nothing but wood. The practical result of the use of wood in these cars amounts to saving 18,000 tons of steel. The wooden centre sills are made of 6 x 12-in. sticks placed 15½ ins. apart. These sills are 5 1/16-in. below the centre line of the coupler. Along the bottom edge, and dowelled to the inside, is a buffing sill, 4 x 8 ins. These are almost in line with the centre line of draft, and they extend from one bolster to the other. In this way the centre sills are not eccentrically loaded to any great extend in pulling or buffing.

Over each truck, and between the centre sills, there is placed a grey iron casting, which acts as a draw gear back stop and also as a tie casting to hold the sills solidly in place. The centre plate is cast integral with the back stop tie casting, and the 4 x 8-in. buffing sills are brought up tight to the cast iron member, and form a solid piece of work where solidity and resistance of a high order are required. The cast iron member is made with flanges which underlie the main draw sills and support them, without relying entirely on the holding power of bolts. The castings are also provided with large lips or flanges which overlie the centre sills, and the centre sills are secured to them and, so to speak, hang from them by vertically placed bolts.

The cars are equipped with Farlow draw gear. The front follower of this gear is H-shaped with ways for the yoke arm and seats in pulling against the large surfaces of the cheek blocks. The yoke, 1¼ x 5 ins., is made bigger at the key slot. The coupler key is 1½ x 5 ins. The key has a bearing on each side of 4⅛ sq. ins. The couplers on the ten all-wood cars have shanks 28 ins. long in order that the key-slot may not come too near the ends of the centre sills, and also to give a long leverage for the coupler on the carrier iron. The ends of the centre sills are covered with a malleable iron cap, which extends over and between them, and so ties them together. This malleable iron casting is made to act as a pocket for the oak block, against which the horn of the coupler may strike. This block is faced with a flat wrought-iron plate, 1¼ x 4 ins. It is here so arranged that the horn strikes this plate slightly before the draw springs go solid, so that the cheek blocks are only subjected to pulling forces and are not intended to take up buffing shocks.

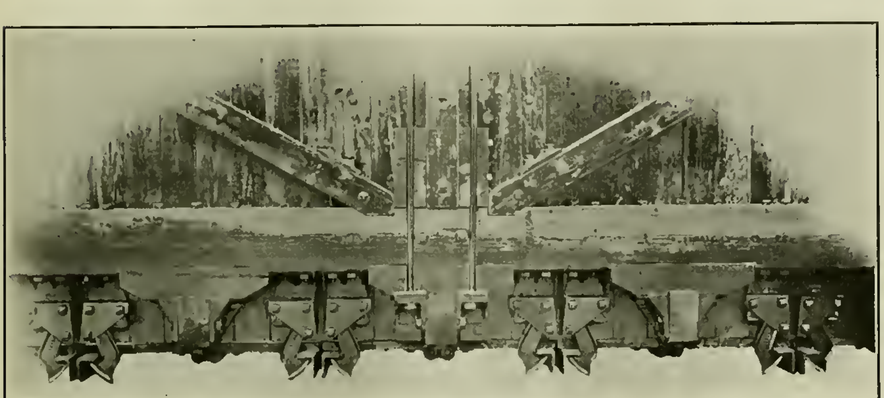
The carrier iron is 5 x 3½ x 7/16 ins., and is a steel angle with ends turned up to form coupler limit stops. It is held by two ¾-in. horizontally placed bolts. It is also supported by the flanges of the malleable iron end-cap casting. When the two carrier-iron bolts are taken out and the carrier iron slipped out, the coupler can be dropped, and the limit stops removed. This permits the draw gear yoke to be drawn out without necessitating the removal of any additional parts. The draught keys are headed at one end, and each has two holes at the sharp end which takes a U-shaped keeper of ½-in. steel, the legs of the keeper being spread similar to those of a cotter pin. Many times, as mechanical men know, trouble has been experienced with closing cotters, and subsequently dropping out. This keeper does not rotate and it is easy to remove when occasion requires.

A flat washer is placed on top of the key, and through it the keeper passes, and so protects U-shaped member from wear. The whole is arranged so that the draw key does not wear in the wood of the sills.

The bolsters for the cars, made completely of wood, are composed of two 6 x 20 ins. yellow pine timbers, passing over the centre sills and under the hopper chute. These rest on top of the centre castings. They are spaced 4½ ins. apart, and the centre casting has a spacing bracket which comes up between the bolster beams and forms a stop. The body side bearings are castings bolted to the bolster beams and braced from the centre sills. The centre sills for the majority of the cars are two channels, 25 lbs., and 12 ins. deep, spaced 16⅜ ins. apart, back to back, with a through ¼-in.

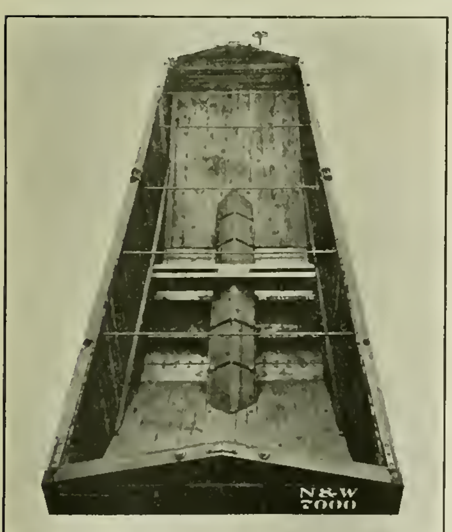
cover plate, 22⅜ ins. wide, and with 3½ x 3½ x 7/16 ins. reinforcing angles on the bottom flanges of the channels. The draw gear attachments are the same as those of the other cars, except that the couplers have the standard 21¼ ins. length of shank, and the malleable cheek blocks are riveted to the inner faces of the pressed steel draw sills. The draw sills are of 7/16-in. tapered steel plates, and are 15 ins. deep at the front ends and 12 ins. at the back, where they overlap the inner faces of the channels, and are spliced to them. This splice takes only pulling forces, the buffing shocks being received by the back stop castings, which are riveted to the main centre sills. The outer ends of the draw sills are vertically supported so that the splice is relieved from the effects of any drooping of the coupler.

The end stakes are made of 4 x 3 x ¼ in. angles, and the oak striking blocks are absent, while the remainder of the draw gear attachments are the same as those on the other cars. The body bolsters for the composite cars are two 33-lbs. channels 15 ins. deep, with top and bottom cover plates. The draw sills are made in channel section and have their flanges turned inward, the pocket between the webs being 15½ ins. wide. The side framing and body construction are so made as to carry most of the load weight on the side trusses, so that the centre sills only have limited bending stress due to the vertical pressure of the load. In order to do this, a transverse needle beam is provided at the centre of the car. It is composed of two 4½ x 12 ins. timbers, spaced 4½ ins. apart, passing through the cavity of the car, over the centre sills. The ends of these needle beams are carried on the side trusses, practically making the centre sills into two beams, suported at the bolsters and the central needle beam.



SIDE FRAMING N. & W. ALL-WOOD CAR.

The cars have four pairs of transverse drop doors, reaching from side to side under the centre sills. They are hinged to door beams, which are supported from the side trusses, from their outer ends. The free ends of the doors have angle irons of slightly greater length than the doors and which reach across the car, and beyond the side planking and are supported when closed, from the side trusses. The weight of the load on the doors is supported one-quarter on the centre sills, and three-quarters on the side frames. The doors are arranged to swing up by hand, and pivoted hooks, working in the malleable brackets, drop under the projecting ends of the door angles. To drop the doors it is only necessary to knock out the hooks. A lock is provided so that the doors cannot fall open unless desired. They are so made that every tendency is for the weight, and the vibration of the car is to draw the hooks into closer engagement, and prevent their slipping out.

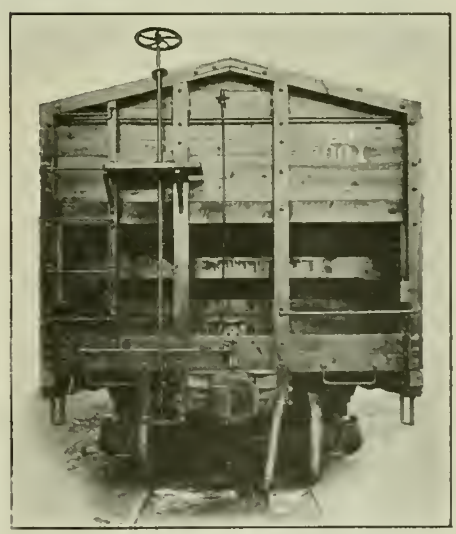


INSIDE OF N. & W. HOPPER CAR.

The framing of the car is unique. Instead of ordinary diagonal bracing rods, etc., the side framing is formed into a king post truss. The main vertical truss rods at the centre are two ⅞ ins. U-bolts, which straddle the timbers and which directly support the centre door beams and the ends of the needle beams. The heels of the trusses are at the bolsters, and are gray iron pocket castings, to hold the lower ends of the main diagonal members. These are tongued and bolted to the through side sills. The side sills are continuous, 4½ x 9 ins. timbers which form the bottom of the truss. The diagonals are 4½ x 8 ins. and the through top plates are 4½ x 6 ins. pieces. The intermediate braces, and the side and corner stakes are 4½ x 4½ ins. At each side there is a ⅞ in. diagonal truss rod which supports the end of the side framing beyond the bolster and prevents drooping, and the ends of the car form a transverse truss for downward forces from the coupler, as well as provide end coal boards. A ⅞ ins. intermediate truss rod is introduced between the bolster and the centre of the car to support the side sill, and this and the vertical disposition of side planking, relieves the side sill from vertical bending stresses.

Some of the dimensions of the car are, length inside, 33 ft. 4⅞ ins.; length over body, 33ft. 4½ ins.; length over striking faces (all-wood car), 34 ft. 9½ ins.; length over striking faces (composite car), 34 ft. 8½ ins.; coupler spacing (all wood car), 37 ft. 1 in.; coupler spacing (composite car), 37 ft. 3 ins.; truck centres, 23 ft. 6½ ins.; inside width, 9 ft. 2¼ ins.; extreme width, 10 ft. 4 ins.; height top of sides above rail, 10 ft. 9½ ins.; extreme height, over brake shaft, 12 ft. 6 ins.; volume, level full, 1,980 cb. ft.; volume, 30 deg.; heap, 370 cb. ft.; total volume, 2,350 cb. ft.; light weight, 42,300 lbs.

The design of these cars was made under the direction of Mr. W. H. Lewis, superintendent of motive power of the Norfolk & Western and Mr. J. A. Pilcher, mechanical engineer of the road. The cars were built in the company's shops at Roanoke, Va. It is intended that the all-wood and the composite cars will be indiscriminately handled in trains of all steel equipment in heavy trains, for which service they are quite fit.



END VIEW OF N. & W. CAR.

Westinghouse Phoenix Office Moves.

The Westinghouse Electric & Manufacturing Company announces the removal of its office from Phoenix, Arizona, to Tucson, Arizona.

Railway Service and Coal

The International Correspondence School of Scranton, Pa., of which Mr. Ralph E. Weeks is president, has lately introduced in what they call their Railway Service Division, a highly important and at the same time, patriotic movement. It is a course of study which has for its object the careful instruction of those who avail themselves of it, in the matter of coal saving. This course of study is not only timely, but just now it is patriotic. It is timely because the art of burning coal has been brought to a high state of efficiency, the theory has been sought out and reasons for combustion and the theory of it agree, and practice has been advanced, so that it is no longer necessary to work by rule of thumb. It is patriotic now because every saving which can be introduced and result in such economies as food conservation, bringing forth farm produce and material economy, is of the utmost importance to us as a nation during these days of stress.

The International Correspondence School with Mr. Edward M. Sawyer as manager of the Railway Service Division, has offered free of charge what they call normal school instruction to any traveling engineer, fuel supervisor or instructor that a railway company may send to Scranton, and this course embraces a week, and enables those who take it to go back each to his railway and give the men under his charge the benefits of what information he has imbibed at the school. Speaking of the work, Mr. Weeks says: "The object of this educational campaign is not only to instruct the men in the methods best adapted to fuel economy, but also to instruct them in the best methods of burning the low grade fuels that frequently must be used, so as to avoid trouble due to engine failures and the consequent disarrangement of railway train service. At the present time, students of the railway courses comes to Scranton for personal instruction from all sections of the United States and Canada. Some of these men are sent in by their company officials at the railway company's expense. Should a railway superintendent of motive power or manager decide to send one or more employes to receive this course of instruction, the men receive a week's training and tuition and are provided with the necessary stationery and other material without charge."

The course laid down is very full, and is given in a series of lectures by competent men. The course itself consists of lectures as follows: *Monday*, 9 a. m. to 10—Opening remarks by Mr. J. F. Cosgrove. Subject, "Coal." 10 to 12, first talk on Fuel Economy, A. G. Kinyon. 2 p. m. to 4—The Conservation of Steam. Blows and Steam Leaks. How to Locate and Book Work and Discussion. 4 to 5—Answers to Questions Applicable to Day's Work. *Tuesday*, 9 a. m. to 11—Second Talk on the Burning of Coal. 11 to 12—Answers to Questions on that Subject. 2 p. m. to 4—Locomotive Drafting. 4 to 5—Writing Answers to Questions on this Subject. *Wednesday*, 9 a. m. to 11—Repeat First Talk on the Burning of Coal. 11 to 12—Writing Answers to Questions Pertaining to that Subject. 2 p. m. to 4—Locomotive Superheaters. 4 to 5—Miscellaneous. *Thursday*, 9 a. m. to 11—Second Talk on the Burning of Coal. 11 to 12—Subject to be Selected. 2 p. m. to 4—Mechanical Firing. 4 to 5—Repeat Talk on Blows. *Friday*, 9 a. m. to 10—Lubrication and Lubricants, by J. F. Cosgrove. 10 to 12—Locomotive Management. 2 p. m. to 4—General Review of Subject, 'Burning of Coal." 4 to 5—Writing Answers to Questions. *Saturday*, 9 a. m. to 10—Feed Water Heating. 10 to 12—Best Methods of Apply the Principles Taught During Week's Instruction. 2 p. m. to 5—General Review and Answering Questions.

Mr. James F. Cosgrove, the well-known textbook writer and who is also an authority on coal, is in charge of the railway instruction work at Scranton. He has had twenty-five years' experience in work of this description, and has not only personally supervised the writing of nearly all the schools' literature on locomotive work, but personally trained his corps of assistants. His knowledge and training is supplemented by having for instant use at all times one of the most complete study and lecture rooms to be found anywhere, and a locomotive instruction apparatus second to none.

All through, the course the instruction is practical, given by men who have actually done the work they talk about. Without for a moment disparaging other institutions of learning one may truthfully say that there pervades the remarks of those who speak, that subtle, convincing line of reasoning which while it may lack the academic touch of a university, nevertheless makes up for that seeming deficiency with the intense practicability of statement, which forms the belief of the speaker, backed by the experience he himself has been taught, in the days when he was called on, not to set others right, but to do his duty and use his brains for the terribly real reason that he was compelled to "make good" to the railway that employed him or give way for someone else. He had to do his work rightly or say he could not.

This training takes from any man a dogmatising assertion of opinion. A discovery made in his young days, though new to the maker, had to meet the frankly hostile criticism of his associates, and if it stood firm against so vigorous a test, it was for the man making it, truhful and complete and above the price of rubies. It is this kind of training that the lecturers at the correspondence school bring into the class room and their experience is given to the students at full value and free of cost.

The work done by the school is, as we said, important and patriotic, and, as far as we know, such an exhibition of fine feeling and good performance has not been given before in this country. "Let him that heareth, say come, and him that is athirst come" and drink of the waters of knowledge. As our representative entered the doorway of the building a class of sixty students came out, having listened to a lecture on the chemistry of combustion practically applied to railway conditions on the foot plate today.

It requires a volume of free air equal to the cubic contents of two ordinary box cars, to pass through the firebox for every shovelful of coal (15 lbs.) thrown in by the fireman. Why this is so and how to get it, are handled in the lecture room. A cube of coal 2¾ ins. on an edge weighs one pound and requires 6¾ ft. of oxygen for its combustion. Air mixed with nitrogen—that inert gas—causes the total air volume to be much greater than this. The government estimate for 1915 (with coal at $1.80 per ton), was one which gave $324,000,000 preventable waste. The coal so wasted, if put in 80,000 lbs. capacity cars, would use up 90,000 trains of 50 cars each. Locomotives burn 20 per cent. of all the coal mined in the United States, so that preventable waste is not only a huge railroad problem, but is a national economic question as well. It would take a man over 14 years to count the dollars, at 100 a minute, representing the preventable waste in money for 1915. So very large a question, in these days of conservation of natural resources, demands attention, and the powdered fuel companies, the oil fuel companies, and the ordinary coal companies are doing what they can to meet the case. The International Correspondence School, with its choice of practical instruction in 280 callings, and very noticeably in railway work, is doing its best to assist those who honestly want to reduce waste in fuel, oil or solid, by telling and showing how it can be done on a railway. It is good business well applied and traveling engineers, fuel supervisors and even master mechanics who would like to have a brush up on these matters should go to Scranton and see how it would suit their men.

The present war shows us how the economic resources of a country can be isolated, and is it not our duty to examine every legitimate method of saving; and here knowledge is power.

Pacific 4-6-2 Type Locomotives for the Baltimore & Ohio Railroad

The Baldwin Locomotive Works has recently completed an order for ten Pacific or 4-6-2 type locomotives for the Baltimore & Ohio Railroad. These engines are designated as Class P-4 by the Railroad Company, and are in many respects similar to the Class P-3 locomotives turned out by the same builders in 1913. Class P-3 has been doing excellent work in high speed passenger service on the Philadelphia Division, of the B. & O., while the new engines have been sent to the western end of the system. Classes P-3 and P-4, although high powered, modern locomotives, are built to conservative dimensions. The two designs differ principally in the details, a thorough revision having been made in the Class P-4 locomotives, in order to fit them for the particular requirements to be met. These engines develop a starting tractive force of 33,560 lbs., and with a liberal ratio of adhesion will be able to fully exert this amount under ordinary rail conditions.

The boiler has a straight top, and measures 72 ins. in diameter at the front end. It contains a moderate amount of well-disposed heating surface, no attempt having been made to crowd the tubes at the expense of circulation. The boiler contains a superheater and brick arch, and is equipped with a power-operated fire-door. Flexible bolts are used in the breaking zones in the water-legs, and the front end of the crown is supported by four rows of expansion stays, twelve bolts wide. The smoke-box is of the self cleaning type, and is designed in accordance with B. & O. practice, without a front extension; but the tube sheet is placed well back of the stack center, and the total length of the smoke-box is 81 ins. The main and auxiliary domes are both placed on the third boiler ring, and the opening under the auxiliary dome is 16 ins. in diameter, so that the boiler can be easily entered for inspection purposes. Two baffle plates, to prevent the surging of the water, are placed in the boiler, one near the middle of the barrel and the other just forward of the firebox.

The main frames are of carbon cast steel, annealed, 5 ins. wide. They are strongly braced, and the pedestal binders are secured by three bolts on each side. Self-adjusting wedges are applied, and long journals are used on the main axle. The front truck is of the Economy constant-resistance type, and the rear truck is of the "KW" type, as supplied by the Commonwealth Steel Co. This truck is used in combination with the Commonwealth rear frame cradle, and is equipped with a centering device. The spring rigging is cross-equalized back of the rear drivers, and connection with the truck frame is made by a vertical link on each side.

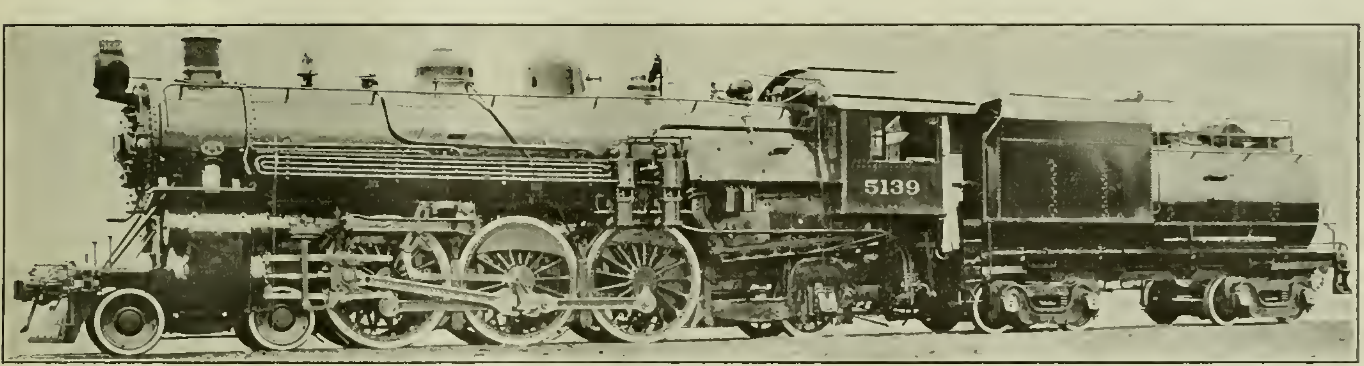
The machinery details include a number of features worthy of mention. The pistons have forged steel bodies, with bearing rings and packing rings of gun iron. The bearing rings are secured by plugs and retaining rings, which are electrically welded into place. No extension rods are used, but the bearing rings are widened on the bottom so that the piston has ample supporting area. Gun iron is also used for the cylinder and steam chest bushings, crosshead shoes, and valve bull rings and packing rings. The valves have cast iron bodies and light cast steel heads, and are set with a travel of 6 ins. and a lead of ¼ in. Walschaerts valve motion is applied in combination with the Ragonnet power reverse gear. The main crank pins are of chrome vanadium steel, annealed.

The tender is of the Vanderbilt type, which has been used very extensively in freight service on the B. & O. railroad, and is now being adapted to passenger service. These tenders have capacity for 9,000 gallons of water, and 16 tons of coal. They are equipped with coal pushers, and are so designed that water scoops can be subsequently applied if desired. The trucks are of the pedestal type, with cast steel frames and equalizers; while the tender frame is of cast steel made in one piece. A radial buffer is applied between engine and tender.

Careful attention has been given to the location of the cab fittings and the design of smaller details, so that the locomotives can be conveniently handled. The equipment includes an electric headlight and a speed recorder.

The leading dimensions are as follows:

Gauge, 4 ft. 8½ ins.; cylinders, 23¾ ins. x 28 ins.; valves, piston, 14 ins. diam. Boiler—Type, straight; diameter, 72 ins.; thickness of sheets, 11/16 in., 23/32 in., ¾ in.; working pressure, 190 lbs.; fuel, soft coal; staying, radial. Firebox—Material, steel; length, 108⅛ ins.; width, 75¼ ins.; depth, front, 74 ins.; depth, back, 59 ins.; thickness of sheets, sides, back and crown, ⅜ in.; thickness of sheets, tube, ½ in. Water Space—Front, sides and back, 4½ ins. Tubes—Diameter, 5½ ins. and 2¼ ins.; material, steel; thickness, 5½ ins., No. 9 W. G., 2¼ ins., 0.125 in.; number, 5½ ins., 25; 2¼ ins., 140; length, 20 ft. 0 ins. Heating Surface—Firebox, 185 sq. ft.; tubes, 2,359 sq. ft.; firebrick tubes, 26 sq. ft.; total, 2,570 sq. ft.; superheater, 604 sq. ft.; grate area, 56.5 sq. ft. Driving Wheels—Diameter, outside, 76 ins.; journals, main, 10½ ins. x 21 ins.; journals, others, 9½ ins. x 13 ins. Engine Truck Wheels—Diameter, front, 36 ins.; journals, 6½ ins. x 12 ins.; diameter, back, 46 ins.; journals, 8 ins. x 14 ins. Wheel Base—Driving, 13 ft. 2 ins.; rigid, 13 ft. 2 ins.; total engine, 34 ft. 3½ ins.; total engine and tender, 70 ft. 6¼ ins. Weight—On driving wheels, 165,100 lbs.; on truck, front, 44,900 lbs.; on truck, back, 45,500 lbs.; total engine, 255,500 lbs.; total engine and tender about 422,000 lbs. Tender—Wheels, diameter, 36 ins.; journals, 6 ins. x 11 ins.; tank capacity, 9,000 U. S. gals.; fuel, 16 tons. These engines are used in passenger service on the Western division of the line.



F. H. Clark, Gen'l S. M. P. BALTIMORE & OHIO 4-6-2 CLASS P-4 Baldwin Loco. Wks., Builders

Chilled Iron Car Wheels

Recently a paper was prepared for the Railway Club of Pittsburgh by Mr. Geo. W. Lyndon, president, and Mr. F. K. Vial, consulting engineer of the Association of Manufacturers of Chilled Car Wheels. The paper was a general survey of the mechanics of the chilled iron car wheel, and many points were brought out that are very apt to be forgotten or overlooked. Steel has been substituted for iron in the rail, with wood in the construction of cars, and has found appropriate places in locomotive construction, but it has not forced out chilled iron in the car wheel. Why is this? The writers of the paper answer that chilled iron has been found by continuous use for 67 years to be thoroughly well fitted for the service it has to perform, and that the process employed in making the wheel, and the material itself are most satisfactory. It has stood the practical test and has not failed.

Chilled iron was introduced in 1850, and its principal and most useful feature is its ability to carry any load that the wheel can bear without crushing or flowing or otherwise becoming deformed. The association with which Mr. Lyndon and Mr. Vial are connected claim their banner year of scientific progress was 1909, when they were able to reduce the large and heterogeneous list of special wheels for cars, to three standard patterns for thirty-, forty- and fifty-ton cars. The general design of these wheels is good, as proved by continuous service ever since.

Satisfactory as the progress so far made has been, other improvements have been brought to light. One of the most important is connected with increasing the flange. This can be done without altering existing track conditions, and a much stronger and better flange would be the result for the heavier varieties of cars. This is not a fad or fancy of the association or merely a desire to play with something new. The manufacturers believe that an increased factor of safety will be the result of the change, and that they are entitled to a definite answer that will affirm or deny this statement, with reasons. They also believe that time is unnecessarily lost in handling the matter, and that the M. C. B. Association and all others whose interests are affected should "show cause," as legal courts say, why the change should not be made, and made with authority without further delay.

Among the advantages which chilled iron wheels possess, and as the writers of the paper say, which have contributed to its reputation, are the following:

"First—Hardness of tread, which gives a maximum service for the least loss of metal.

"Second—The coefficient of friction between wheel and brake shoe is 25 per cent greater than that developed by steel under the same pressures. This is of great advantage in reducing the strain on the brake rigging and trucks, by practically giving greater capacity to air cylinders and air pumps on the engines, etc.

"Third—The durability of brake shoes when used on chilled iron is 25 per cent to 100 per cent greater than when used with other materials, the variation depending upon the type of shoe used. The slow-wearing insert shoes commonly used on chilled iron wheels cannot well be used on the steel wheel on account of their scoring action.

"Fourth — The abrasion between a chilled iron flange and a steel rail is less than that of a steel flange against steel rail. The chilled iron flange reduces the loss in metal from the flange and also from the rail, which is an item of economical importance.

"Fifth—That part of train resistance which is developed through flange friction and tread slipping, is materially less in the case of chilled iron wheels than with other wheels. This is one of the most important items of economy in connection with the chilled iron wheel.

"Sixth—A chilled iron tread, on account of the absence of ductility, retains its rotundity to a greater extent than is possible in treads made of other materials. Large numbers of broken rails have been found by thorough investigation to have been caused by eccentric wheels. The ordinary flat spots of 2½ ins. occurring in the chilled iron wheels do not produce anything like the impact blow that is developed in the case of an eccentric wheel. In case the flat spot is ironed out, an elongated flat spot or an eccentric wheel is produced. This does not occur in the chilled iron wheels and, therefore, a noise is developed such that the location of the defect is easily discovered, which is not the case with the eccentric wheel.

"Seventh—The scrap value of a chilled iron wheel is relatively greater than that of any other material, largely on account of the scattered locations of wheel foundries throughout the country. This is especially true in the West.

"Eighth—Chilled iron will carry heavier loads without distortion or cold rolling the surface metal than is possible with other metals.

"Ninth—No expensive lathes are required for machining treads, thereby effecting a saving in shop and machinery."

Since 1875 wheel loads have increased 500 per cent, axle weights 205 per cent, and wheel weights 75 per cent. The phenomenal and rapid growth in wheel loads is well known. Notwithstanding this rapid development, statistical information shows that the number of wheel failures during the past ten years are far less in percentage than during the decade prior to the introduction of the 100,000 lbs. capacity car. This favorable record has delayed a study of the relations of stresses originating in service and the factor of safety in different parts of the wheel. An analysis of wheel failures strongly indicates that the majority occur because of an entire disregard of the rules of standardization and extremely unfair usage.

During the years 1914 and 1915 the M. C. B. Wheel Committee made a special effort to collect from all the railroads, and tabulate all failures of chilled iron wheels with particular reference to flange failures and cracked plates. Contrary to expectations, extremely few broken flanges were reported, and the item of cracked plates was 30 per cent more prevalent in the 60,000 lbs. capacity cars than in the 100,000 lbs. capacity cars, and more than half of the cracked plate wheels in the 30-ton cars were confined to cars above 42,000 lbs. light weight, which constitutes less than 5 per cent of the total equipment in that class. This indicates that the load carried is not a true criterion of stresses developed within the wheel. It is certain that wheel failures would be practically eliminated if the magnitude and intensity of the internal stresses, which are developed by various operating conditions, were fully established and the wheel designed and used accordingly. No investigation along these lines has ever been attempted by committees who fix wheel standards, and the rules established by manufacturers are not officially recognized. If we review the M. C. B. proceedings we find hundreds of pages of valuable information regarding the properties of brake shoes and other parts of the car, but nothing whatever to indicate a constructive effort to establish the fundamental properties of chilled iron or the origin and magnitude of the stresses within the wheel. Inasmuch as loads 50 per cent in excess of those required under 100,000 lbs. capacity cars are now safely carried by chilled iron wheels, it is well to consider whether wheel loads of 30,000 lbs. are nearing the limit of capacity of chilled iron, and if so, in just what way it will become manifest in different parts of the wheel. The particular items requiring investigation to establish this information are: Bearing power of chilled iron, the effect of cone on wheel and rail service, the stresses developed, within the flange, in the plate from flange pressure, by vertical load from axle pressure, in the plate by heat from brake friction, coefficient of friction and rate of metal loss in shoes continuously applied at varying pressures and velocities.

Chilled iron wheels are not appreciably flattened by any load below 250,000 lbs. As far as bearing power is concerned, chilled iron is ideal for wheel service, and in addition thereto, the metal takes on a high polish and produces a minimum amount of friction when rubbing against the rail, which is a quality of prime importance. The absence of ductility prevents distortion of the metal; therefore, the tread maintains its original shape as regards taper and the wheel as a whole retains its rotundity to a greater extent than is possible with any other material. From all tests which have been made it is safe to assume that the average pressure per square inch over the contact area between wheel and rail is about 100,000 lbs. For extreme loads above 200,000 lbs. on curved top rails, the pressure per square inch may reach 150,000 lbs. When the top of the rail is worn, the bearing area is increased, and the pressure per square inch is correspondingly reduced.

The first permanent set, which indicates passing the elastic limit of the rail, occurs when the indentation or penetration is approximately .007 inch. If we assume that in regular service, the wheel load will be such that the indentation shall not exceed one-half this amount, we have the following results for maximum permissible wheel loads in railway service:

On wheels 42 ins. in diameter—Load limit 34,000 lbs.

On wheels 36 ins. in diameter—Load limit 31,500 lbs.

On wheels 33 ins. in diameter—Load limit 30,200 lbs.

On wheels 30 ins. in diameter—Load limit 28,800 lbs.

An indication of the bearing power of chilled iron is obtained from crane service where concentrated loads of over 100,000 lbs. per wheel are not uncommon. One use for wheels of this type is to carry unloading bridges and large gantry cranes. On account of the extreme width of span, which may be more than 200 ft., the rails are not always parallel, especially when one rail is on the dock line. A spreading track brings strong pressure to bear on the flanges of the wheels, which are double on these wheels, therefore the flanges are designed to climb the rail under full load and still have a factor of safety against breaking of 4 or 5. From the above analysis, and in fact from general experience, it appears that 30,000 lbs. load for a 33-in. wheel is about the limit of rails of the present type. As far as wheels are concerned, double this load can be carried without the least sign of overload.

The limiting loads will always be governed by the bearing power of the rail rather than any consideration on the part of the wheel itself. For this reason chilled iron is ideal not only for railroad service, but also for wheels under the heaviest concentrated loads such as occur under transfer tables, special cranes, unloading towers, swing bridges, gantry structures, etc., where the wheel load may exceed 100,000 lbs.

It was early found that a certain amount of cone in the tread of a new wheel was advantageous from every standpoint. The present cone is 1 in 20. This is the recommended standard of the M. C. B. Association, and also standard in Europe where the practice is about equally divided between a uniform taper and a slight double taper. The world's standard may be said, without exaggeration, to be 1 in 20. Two railroads have other tapers and these deviations have called for a discussion of the whole subject and various rail and wheel committees are now at work to determine the best standard. It is highly desirable that there should be but one standard taper. The paper, which is extremely full of most valuable matter, too extended and accurately minute for other than passing notice here, concludes with determinations of coefficients of friction, effect of heat by friction, results of brake shoe action, effects of brake shoe-induced heat, tensile and compressive stresses under load, rise of mounting pressure, heat defects, and defects developed in service, which were formerly thought to be inherent blemishes, and some conclusions drawn from a close survey of the whole question of the utility of the chilled iron car wheel in railroad service.

Opinion of the Interstate Commerce Commission

The report of the Interstate Commerce Commission on the collision at Mount Union, Pa., February 27, 1917, and the conclusions of the committee are quoted below:

"The circumstances surrounding this collision point clearly to the conclusion, often reiterated in previous reports, that if accidents of this character are to be guarded against, some form of automatic device must be used which will assume control of the train and bring it to a stop within the zone of safety whenever an engineman fails for any reason to obey a signal indication that restricts the movement of his train. The only alternative that suggests itself is reduction of speed to a point that will enable an engineman to bring his train to a stop within the range of vision under all conditions of weather.

"The condition of dense fog is an almost invariable accompaniment of accidents of this character. In numerous reports attention has been called to the danger of permitting fast trains to proceed at undiminished speed when signals are obscured by fog or storm so as to limit greatly an engineman's range of vision. When operating trains in block-signal territory in foggy weather, enginemen usually make no reduction in speed as long as they are sure of the signal indications, even though signals can be observed but a few feet ahead of the engine. Theoretically this is safe, as the signals indicate the condition of the track ahead with as great certainty in foggy weather as in clear, and if a signal is seen and known to be clear there is no good reason why speed should be reduced. But, however, safe this practice may be in theory, experience has amply demonstrated that as a practical matter it is not safe. The chance of misreading a signal from a rapidly moving train is immeasureably greater when fog is so dense that the signal can be observed but a short distance than when the atmosphere is clear enough to permit normal observation of signals.

"To have required the speed of this train to be reduced so that it could be stopped within the engineman's range of vision might well be considered excess caution; yet, in view of the engineman's feeling of certainty that his observation of the signal was accurate, this was obviously the only absolutely safe course under the existing conditions. Had there been an automatic train stop installed braking distance in the rear of signal bridge 1904, however, neither the speed of the train nor the misreading of the signal at bridge 1912 would have prevented the train from being brought to a stop in time to prevent this collision.

"There are a number of automatic stop devices now available for use which are capable of development to meet railway operating conditions in a practicable manner. This work of development must be done by the railroads themselves. The works which the Government is doing in examining and testing automatic train control devices can go no further than to indicate whether or not the devices tested are correctly designed and capable of being developed so as to perform their intended functions in a proper manner. It is obviously a duty which the railroads owe to the traveling public to develop and use these devices to the end that these distressing accidents, due to human error, may be eliminated from railway travel."

The Interstate Commerce Commission has approved the stop-signal idea in no uncertain way, and has indicated the duty of the railways to adopt it. Now that the Government "owns" the railways, whose duty is it?

Locomotive Ash Pans

Their Development Under the Federal Law—Some of Their Varieties In Design

It is now nearly ten years ago that by an act of Congress it was declared unlawful for any common carrier to engage in interstate or foreign commerce by railroad to use any locomotive in interstate or foreign traffic, not equipped with an ash pan, which can be dumped or emptied and cleaned without the necessity of any employee going under such locomotive. Although the rule was clothed in much verbiage, and full of repetitions, the object aimed at was clear, and the penalties attached rendered the law mandatory in its application. The only exclusion from the application of the law was the statement that nothing in the act shall apply to any locomotive upon which, by reason of the use of oil, electricity, or other such agency, an ash pan is not necessary.

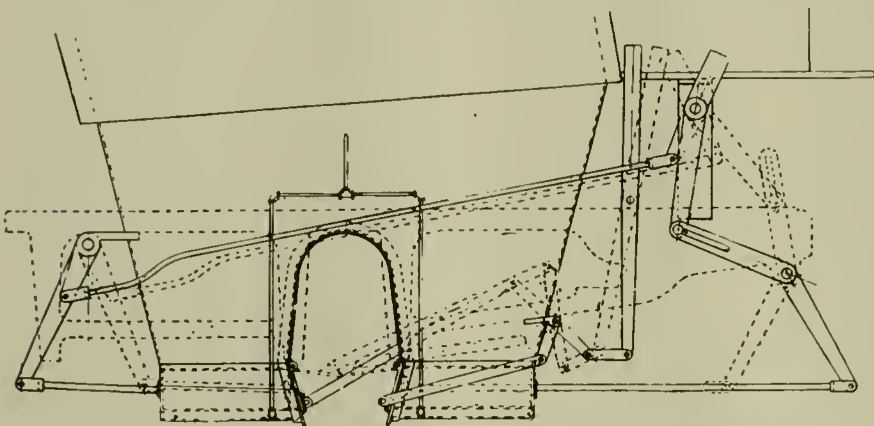


FIG. 1. ATLAS SELF-CLEANING ASHPAN FOR LOCOMOTIVES.

Later an amendment was added to the original law setting forth instructions that ash pans shall be securely supported and maintained in safe and suitable condition for service on locomotives built after January 1, 1916, and must be supported from mud rings on frames. Locomotives built prior to January 1, 1916, which do not have the ash pans supported from mud rings or frames shall be changed when the locomotive receives a new fire box. The operating mechanism of all ash pans shall be so arranged that it may be safely operated, and maintained in safe and suitable condition for service. No part of the ash pan shall be less than 2½ ins. above the rail.

In the hands of the well-trained mechanical engineers the problem was not a difficult one, and a universal compliance with the law was completed with a degree of rapidity that was agreeably surprising. As may be expected there was, and is still, a great variety of devices looking towards a solution of the problem of cleaning the ash pan without the necessity of going into the pit under the locomotive. The fact that there has not been developed any special device that has met with universal adoption may be looked upon as proof that all or nearly all the appliances in use are satisfactory, but this does not prevent our inventors from producing from time to time some new form or variety of device claiming attention. The winter through which we have just passed has furnished the severest kinds of tests on the reliability of devices during the intense frosts and heavy snowfalls, and it is not to be wondered at that new ideas are taking form, especially looking towards anti-freezing appliances guaranteeing the free working of the devices under the conditions recently experienced.

The hopper shaped ash pans with sliding bottoms and heavy cast iron, and in many cases with thinner cast steel sliding plates which may be actuated by levers, are generally in use. During winter the real test occurs of the efficiency of these types when the level sliding plates or castings are in use. On many roads the climatic conditions have been such as to render the efficiency of the apparatus difficult of accomplishment, and hence it is not to be wondered at that some clever devices in the way of steam pipes and other appliances calculated to thaw out the frozen parts and force out the adhering ashes are already in use.

One of the earliest designs calculated not only to meet the requirements of the Federal law but also prepared to meet the natural exigencies arising was what is known as the Atlas ash pan. This pan is arranged so that any leakage from the mud ring falls outside and not into the pan. The chief feature of the ash pan, however, as is shown in our illustration, Fig. 1, is the fact that it is fitted with scrapers. These are really like pistons, though of rectangular shape, which by the operation of a lever for each section, may be forced through the length of the pan, thus pushing the ashes out ahead of it. These scrapers, when in normal position, act as dampers for the front and rear of each section. The pan is also fitted with a double bottom which may be filled with steam to prevent freezing in winter.

In many of the earlier ash pans that came into operation with a view of meeting the requirements of the law, the cinders rested against the bottom, and on account of the weight of the cinders the springing of the bottom plates not infrequently made it difficult and not infrequently impossible to operate the slides, and therefore when the slide was opened, it was not closed tightly, leaving the pan in a partially open condition at the bottom, and in some cases causing delay in endeavoring to open or close the slides on account of the slides being very hard to operate.

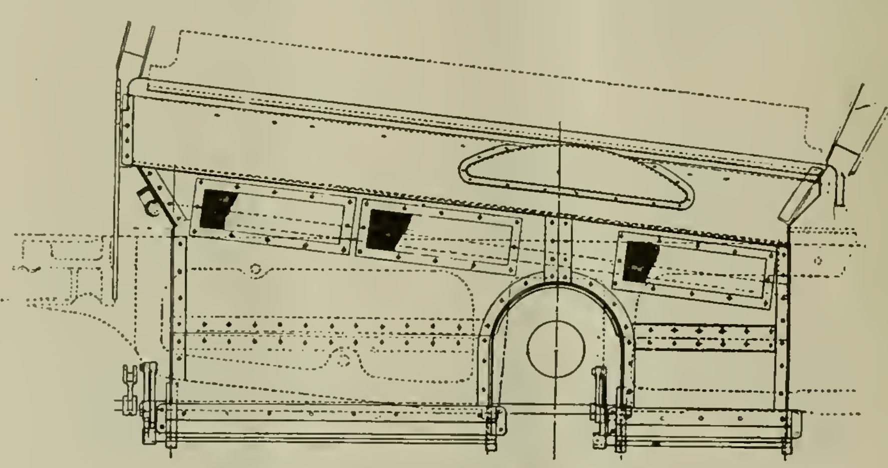


FIG. 2. SYKES SELF-CLEANING ASHPAN.

A device known as the Sykes ash pan, Fig. 2, was contrived with the bottom revolving in two sections, and leaving the bottom of the pan entirely open, with nothing in the bottom on which the cin-

ders could lodge or preventing the pan from cleaning itself freely and closing tight, and in case there might be a cinder or other obstruction and the pan did not close the cinder could be removed by operating the doors, and could be seen from the outside if the slides closed properly. A further peculiarity of this device was means for a flow of water extending the full length of the ash pan immediately over the revolving bottom, which could be, if desired or needed, washed off with a stream of water from the injectors or from a blower attached direct to the boiler, and this being in the form of a sprinkler simply washes the plates, or after the cinders had been dumped to the track could be used for putting out the fire on the track. The ashes could be discharged from this pan from the locomotive by hand, air or steam, as desired, or from the foot-board, or by a lever operated by a man standing on the ground. An advantage is in the fact that it cannot become distorted from the heat and in case of extreme cold weather, when the ashes in the pan may freeze, hot water or steam from the boiler may be readily connected up to overflow pipes, and discharged into the pan prior to dumping it, which will thaw out all the ice, and allow the ashes to be discharged without trouble.

A more recent invention known as the Madden hopperless ash pan, Fig. 3, has attracted considerable attention on account of its simplicity, being entirely constructed of ¼ in. tank steel, eliminating all castings and forgings. The formation of the pan, in what is known as reverse curves, precludes the possibility of warping or buckling. The danger of ashes escaping is also avoided as the ash pan is air-tight except at the mud-ring, where there is an opening of ten to twelve per cent. of the grate area through which to admit air for combustion. The original low cost and the almost complete absence of the need of repairs are advantages in these high-priced times. This design has met with considerable favor in the West, the Missouri Pacific having over 600 in service, and the reports during the recent winter show that this form of ash pan has made an excellent record in severe service. It has also been adopted as standard on the Western Maryland, and is being tried on the Wabash, the St. Louis-San Francisco and other roads.

While these variations in the form and arrangement of operation might be added to, it will be generally conceded that the larger locomotive constructors have met the situation admirably. The extraordinary demands that have been made upon the leading locomotive builders for the increasing and varied transportation service, ranging from the smallest types of narrow gauge locomotives to the heaviest types of Mallets has led to an approach in the standardization of devices and materials that are calculated to meet the requirements of every kind of service, as well as the co-ordination of forms that become readily familiar because of their uniformity. In the matter of ash pans furnished by the Baldwin Locomotive Works, the operating mechanism has received considerable attention, and a degree of soundness of construction as well as similarity in design in the various types has reached a degree of perfection that is eminently satisfactory. Our accompanying illustrations, Figs. 4, 5, 6 and 7, show the details of the arrangements used with a long, narrow firebox, and which, under the most trying conditions, during the severe weather has never failed to be admirably

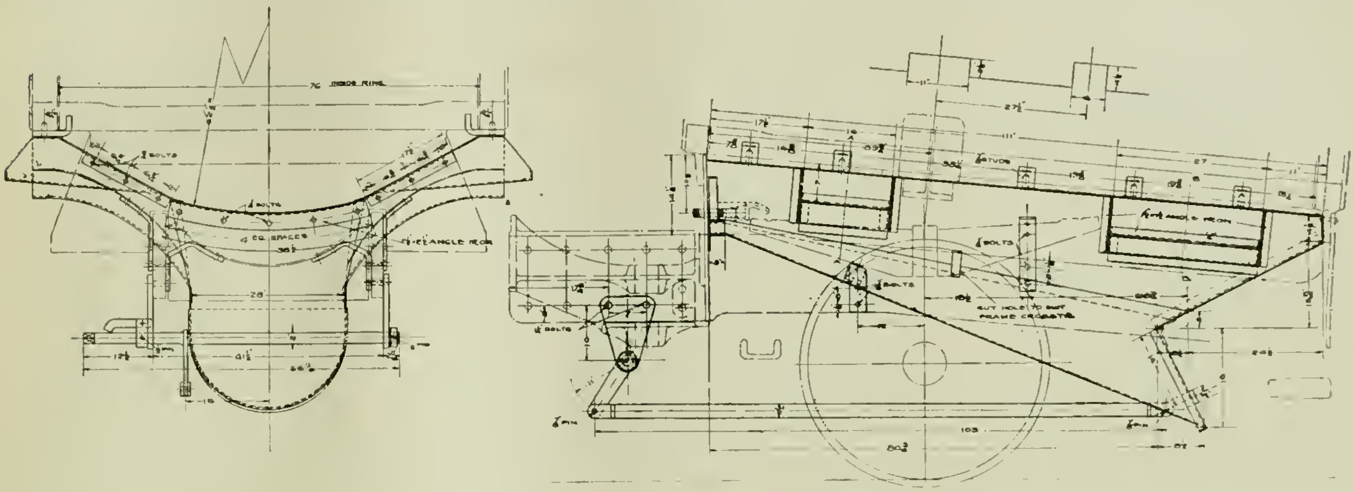


FIG. 3. MADDEN HOPPERLESS ASH PAN, NOW IN USE.

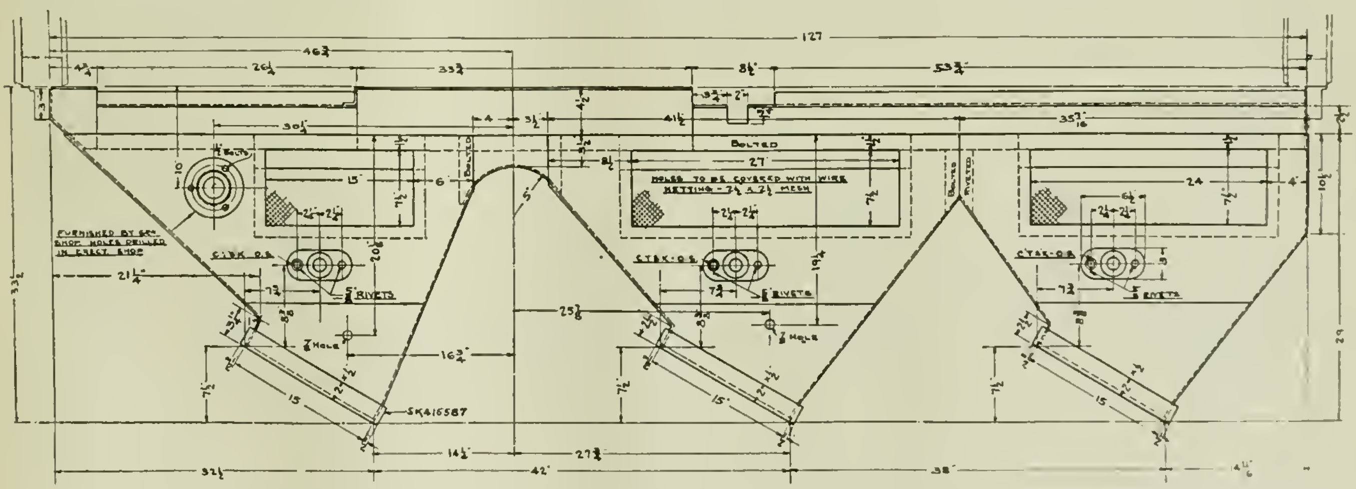


FIG. 4. ASH PAN FOR LONG NARROW FIREBOX—BALDWIN LOCOMOTIVE WORKS.

adapted for the end in view. The details as shown are self explanatory, and it need hardly be pointed out that the openings for the removal of the ashes being at the lowest points of the ash pan the removal of the ashes is instantaneous and complete, while the closing of the movable doors are, by reason of their acting against the contracting surfaces of the ash pan, self cleaning, while the operating levers by reason of their multiplied ap-

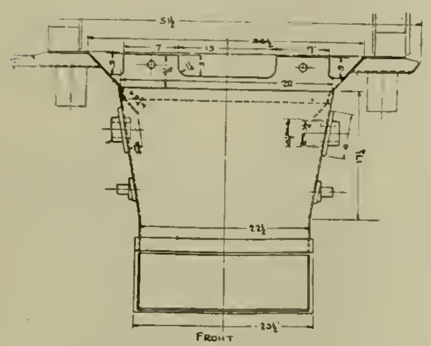


FIG. 5. FRONT OF BALDWIN ASHPAN.

plication of power entirely restricts any leakage while the operating lever is in the closed position. In the absence of any serious collision there is absolutely nothing to get out of order, for even if it were possible for any portion of the ash pan to warp after long service, the overlapping of the movable closing appliances prevents any tendency to admit of an opening at these points of movable contact. It will also be noted that the air openings, which are essential to combustion, are covered with durable netting, preventing any sparks or heated ashes from escaping into the outer air.

It will thus be seen that while the subject of constructing and maintaining ash pans, in order to comply with the existing regulations, may seem at first sight simple and easy of accomplishment, it has received the attention of the ablest constructors of locomotive appliances, as well as that large class of inventors whose minds naturally run to every conceivable channel of human endeavor, and it would not be surprising if the ash pan should assume new forms in the undiscovered future.

A word might be added in reference to the fact that while the ashpan has received considerable attention in recent years, there has come to our observation here and there evidences that there are mechanical engineers who seem to forget that there is such an appliance. It would not be difficult to furnish instances where the mechanics in endeavoring to attach the ashpan in place have discovered pipes, coupling rods, brake paraphernalia, and other attachments so situated that the constructing engineer had evidently given the ashpan no thought. This is not remarkable in view of the fact that in bridging over the axles in some types of locomotives, portions of the ashpan are necessarily circumscribed in area, and this necessity leads to another occasional defect. It is not unusual to find that the limited space in the ashpan immediately over the axles is apt to get choked up with ashes, thereby affecting the combustion in that part of the furnace.

These defects or instances are rare, and the remedy so easy that attention is merely needed to be called to them. The most serious defect, if it may be so called, has occurred, as we have already stated, in the severe weather of last winter when in many instances it became physically impossible to keep the attachments of the more complicated ashpans in good working order, and the need of some adjustable apparatus that may be readily attached for speedily and completely thawing any part of the appliance that may become affected by atmospheric conditions, is so apparent that in the near future it will likely take form in some general way that will meet the needs of the situation, either by the general adoption of some device already in operation, or by some new attachment embodying the simplest and most efficient method of overcoming the difficulty. The ashpan itself may seem simple, and the problems affecting its upkeep easy of solution, but it is not as simple as it looks.

Crippled Cars.

Mr. Charles C. McCord, interstate commerce commissioner, says that thousands

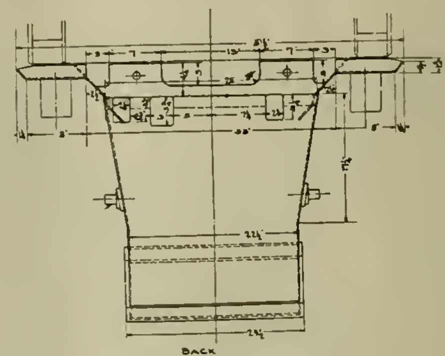


FIG. 6. BACK OF BALDWIN ASHPAN.

of crippled freight cars have accumulated through the winter because of neglect of railroads in making repairs, and that they occupy miles of tracks in eastern railroad centers, and are largely responsible for car shortage and traffic congestion. These cars could have been repaired quickly during the winter if the railways had made proper preparations for covered repair tracks, according to the opinion of railroad administration officials.

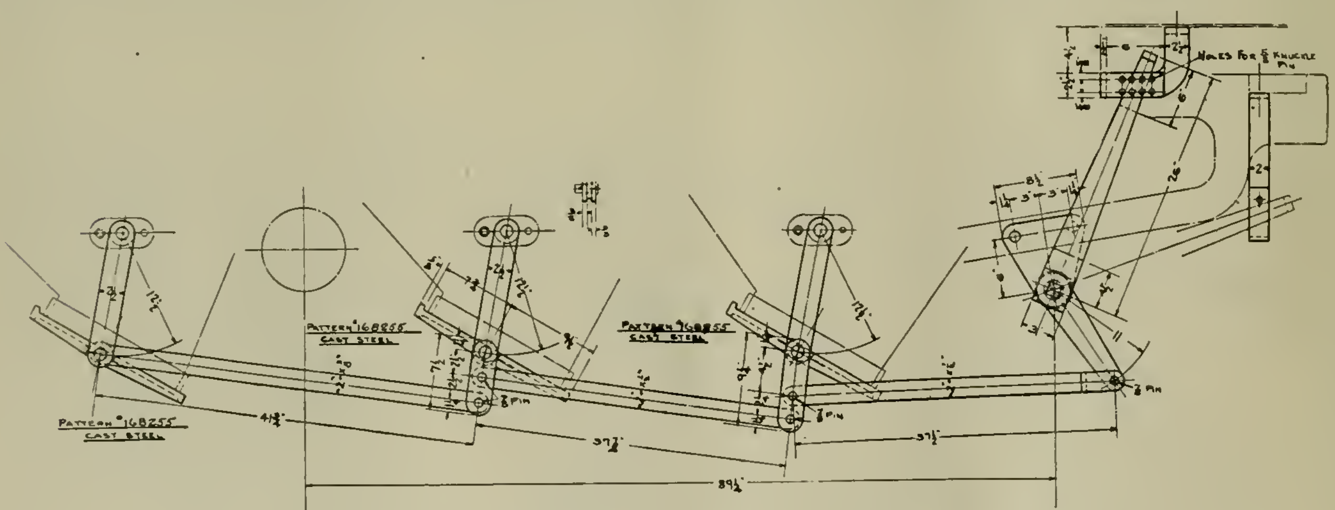


FIG. 7. DETAILS OF OPERATING LEVERS ON BALDWIN ASHPAN.

Saw Setting.

Hand-saws are filed by gripping the blade between two strips of wood held in the jaws of the joiner's vise. The proud teeth are levelled off by passing an old file longways over the teeth. The front angle of the teeth should be about 75 degrees, 90 degrees being at right angles to the line of the tops of the teeth. Set with a hammer and nail punch on the end grain of a block of wood.

Engine Failures—Their Chief Causes and Prevention

The locomotive engineman of to-day can do a great deal to save or waste the railroad company's money, but he is not alone in this regard. One of the most hopeful signs of these perilous times is the intense energy and earnestness with which the railroad man generally, and, in our opinion, those engaged in the mechanical department particularly, are striving towards that degree of perfection in their calling that not only readily meets and masters emergencies as they arise, but foresees them, and takes pains to avoid them. There is no better evidence of this than in the fact that during the severe climatic conditions prevailing last winter, the number of engine failures was reduced to much less than the average of previous years. Times of stress and trial induce a greater degree of serious thoughtfulness, and to this must be superadded the important fact that the vastly improved system of the training of apprentices and the persistent education of firemen is already showing a marked improvement among the railway men that bids well for the future.

In this connection it might be timely to refer in a general way to what are known as engine failures, embracing delays on account of engines breaking down, running hot, not steaming well, or having to reduce tonnage on account of some defect arising in the engine, making a delay at a terminal, a meeting point, a junction connection, or delaying other traffic, or other circumstances that could be readily added to but nearly all of which can be, and, if possible, should be avoided. Experience has shown that engine failures may be classified as arising from recurring causes such as fractures in the mechanism, boiler troubles prevalent in bad water districts, air brake disorders, failures in the boiler feed appliances, blow-off cock and other boiler-mounting troubles, and last, by no means least, failures on the part of the enginemen. Indeed it must be admitted that while the improvements in the varied mechanism, in design and operation as well as in material, are approaching perfection, the human element will never become infallible.

Taking up some of these troubles categorically, it may be said that there are failures in machinery that are unavoidable, and probably cannot be foreseen. Frequent and thorough inspections by enginemen, roundhouse and back shop men are the best means of avoiding these failures. Neglect in the machine shop is invariably heard of afterwards. When work is taken apart in the machine shop it should be thoroughly examined with a view to discover cracks or flaws, and the whitening of rods, axles, frames and crank pins and testing by hammering, or by oiling and drying and lightly hammering, when cracks, if any, will show some traces not otherwise visible to a mere casual inspection, will not infrequently save the possibility of a fracture when the engine is in service. Heating and annealing of parts is also in the line of safety as lessening the brittleness, especially in the case of the lighter parts that crystallize more rapidly than the heavier parts.

In the matter of heated bearings, particularly the driving boxes, it is the special duty of the engine inspector to test the engine for pounds, and the slightest pound in any of the driving boxes should be given prompt attention. If necessary the wedges should be set up, and adjusted at such a degree of tightness that the box should move readily upward and downward without any apparent lost motion. The rod bushings and rod bearings generally cannot be maintained in proper condition unless the driving boxes are kept in good fitting condition in the wedges.

In regard to engine failing to steam well, this defect is frequently caused by the quality or kind of water, and this has more to do with boiler failures than all other causes combined. The boiler should be washed out as often as required, and the frequency of the washings should depend more on the quality of the water, and upon the amount of water evaporated rather than upon the number of trips run or the number of days in which the engine may have been in service. The accumulation of mud may be said to be the chief cause of defective steaming. The removal of a number of flues at the bottom or in scattered locations as may be required will greatly aid in a thorough cleaning of the boiler. Irregular steam pressure invariably cause boiler failures, and if engines are left standing in the open air in excessively cold weather for any length of time under a high pressure of steam the tendency to boiler failure by reason of leaky flues or other defects is very great.

In this connection it might be noted that failures of blow-off cocks, though less frequent, are still among the incidents likely to happen. Sometimes they occur by reason of bolts, nuts and other material left in the boiler carelessly, and gradually gravitating to the blow-off cock, and getting caught in the opening prevent the blow-off cock from closing. Indeed it was not infrequent to hear some of the engineers remark that they would not open the blow-off cock except at terminals in case that they would not be able to close them again as the operating mechanism was not infrequently in such a position that it was difficult to reach. Marked improvements have been made in the operating of the mechanism, and with the use of screens the problem should be completely mastered.

The failure of boiler feed appliances are largely due either to the liming or encrusting of the parts from poor water conditions; the cutting of seats and nozzles; from the presence of sand in the water, and failure on the part of the checks, injectors or valves, and last, but not least, by the failure of pipe joints, more particularly between the tank and the injector, where a defect in a pipe or joint is not only a source of delay and danger, but a source of mystery. Care should be taken to see that injectors are frequently changed and all pipes and joints examined at regular intervals growing out of the average requirements of the service. Boiler checks may require to be refitted or reground every two or three days. Their tendency to leak in bad water districts is great, and a leak from the boiler to the injector pipes has a most injurious effect on the working of the injector.

In regard to air pressure failures; these are being thoroughly overcome by the use of double air pumps, superior piping and reliable joints. The proper clamping of pipes is of itself a feature of importance, as incessant vibrations of pipes never fail to produce a defect at some point. An air brake expert, at one time a rarity, is now to be found at almost every division point, and the appliances generally may be said to be as nearly reliable as any mechanical product can be expected to be, but the details are becoming more multiplex, and their careful handling can only come by experience, combined with such opportunities for instruction as may be gathered from the standard works on the subject, including the department devoted to the subject that is conducted in our pages from month to month.

The growing demand for motive power at the present time has a tendency to increase engine failures, and in order to meet the demand, chances are apt to be taken by officials who, however earnest and well meaning, are often compelled to neglect repairs that eventually cause engines to fail. This may seem at first sight to savor of culpable neglect, but it is only those who have been between what may be called the upper and nether millstone who understand how men are drawn into this state of mind to take chances, and the chances repeatedly succeeding, the human mind changes its consistency, just as a bar of cold steel of superior quality may lose its consistency by repeated blows of a heavy steam hammer until it is not in the form that it should be.

The Stop Signal in England

The stop signal or automatic train control idea, which we have consistently advocated as a safety device of the highest order, has also made headway in responsible quarters in Great Britain, is evidenced by the article we quote from the pages of the Railway Engineer of London. The article appeared under the heading of the "Automatic Train Control."

"Before the war probably no question relating to the safe working of traffic commanded more attention than the question of Automatic Train Control. Of course, during the war, this, along with other pressing questions, has had to be shelved for the time being, and although its consideration has thereby been delayed, it will again compel discussion when more peaceful times return. Unfortunately, in this country, opinion is very sharply divided on the question.

"It is universally conceded that considerable improvements have been effected in the safe working of traffic by the introduction of track-circuiting, but these improvements cannot be considered adequate unless means be adopted to guard against the failure of the human element, in the person of the driver. No matter what methods be adopted to insure that the indication given by a signal shall be the correct one, accidents are bound to occur unless some check is placed on the fallibility of the driver.

"Up to this point it may be said that all railwaymen are in agreement, but when the question of the control to be placed on the driver is considered opinion varies considerably. There are some who argue that the case might be met by the introduction of a system of cab-signaling, wherein the indications given by the fixed signals are reproduced in the cab of the engine. There are others, a little more venturesome, who consider the problem would be solved by the adoption of a system of cab-signaling employing some feature of speed control. For example, should a driver approach a distant signal at caution and it will be appreciated that this system can only be applied to the distant signal, the caution indication will be given in the engine cab, either visibly, audibly, or both, and the train brakes partially applied. In some systems no application of the brakes would be made provided the speed of the train was below a predetermined value. Finally, there are a few bold spirits, in a minority at present, but whose opinion we believe to be correct and likely to prove acceptable when the question is thrashed out afterwards, who believe that nothing short of a full application of the brakes at a stop signal will suffice. This rules out the distant signal altogether, and we think quite rightly so; because the distant signal in modern installations is somewhat an anomaly, and will, we believe, in its present form, be abandoned as the development of the signaling problem proceeds.

"From time to time several articles have appeared in The Railway Engineer urging that the full brake application was the only satisfactory system from a safety point of view, and showing that such a system could embody what are known here as train stops, cab signals, or a combination of the two. The articles also dealt in detail with the reorganization of the signaling system which would be rendered necessary by the adoption of such a system and the advantages which would accrue thereby. Knowing the experience of the people who held our views and the study they had devoted to the subject, we felt confident that we were correct, and in this respect we are pleased to observe that official opinion confirms this in every respect. Colonel Pringle, R. E., in his report dated 17th January, 1917, on the accident which occurred near Kirtlebridge, Caledonian Railway, on 19th of December, 1916, states:

"'I can suggest no other safeguard in analogous circumstances than the adoption of a system of automatic control of trains, whereby the continuous brake is applied when an engineman passes a fixed signal at danger. This case has features which strengthen my opinion that any such system should include provision for a full brake application at an actual stop signal, and preclude the possibility of a driver releasing the brake until after the train has come to a standstill.'

"Lieut. Col. Druitt, in his report on the accident at Wigan on 19th of December last, states that:

"'To prevent collisions under such circumstances as obtained in this case the only solution would appear to be automatic control of trains, by which the brakes are applied when a signal is passed at danger. I consider that, to do this effectively, a full application of the brake should be made if a stop signal is passed at danger, and it would be a further precaution on the side of safety in such cases if the driver was unable to release the brakes until the train had come to a stand, but details of the necessary appliances can only be decided by actual experience.'

"'Systems of automatic control have been under trial by several railway companies for some time, but the question presents many difficulties, for it is manifest that with so much inter-running of one company's engines over the other companies' lines, any system, to be really effective, must be universal throughout the country, and it is possible that there may be more such inter-running in the future. Owing to existing conditions, the matter has not progressed so quickly as it otherwise would have done, but it is to be hoped that it will be satisfactorily settled in due course.'

"Colonel Pringle, to whom all signal engineers are grateful not only for the keen interest he takes in the art, but his acquiescence and approval of any method calculated to increase the safety factor, has also in previous reports clearly defined his attitude on the question of train control. Sir Samuel Fay, general manager, Great Central Railway, who also takes a keen interest in the signaling problem, is reported to have said, in speaking of track-circuiting in particular, 'I am certain that we are approaching a complete revolution all the way round in our system of signaling. What we are doing now is only a commencement.'

"We can only express the hope that railway officials in general, and signal engineers in particular, will be quite ready to discuss new methods and devices, the need of which will inevitably arise when the present European turmoil is over. Unless this will be done with the 'safety first' factor in view all the time, we are afraid that the pressure of official and public opinion will prove too strong, and legislation will be the result."

Conservation of Railway Fuel.

Major Schmidt, formerly professor of mechanical railway engineering in the University of Illinois, and recently assigned by the War Department to the Fuel Administration, held a conference with the members of the International Railway Fuel Association in Chicago recently. The members of the committee are E. McAuliffe, chairman; W. L. Robinson, Baltimore & Ohio; E. W. Pratt, Chicago & North Western; L. R. Pyle, Soo Line, and D. C. Buell, Railway Educational Bureau, and M. K. Barnum, Baltimore & Ohio: John Crawford and A. N. Wilson, Burlington, and Charles Hall, Indiana Coal Operators' Association, also took part in the conference. It is not yet settled whether the matter of fuel conservation on the railways will be handled by the Fuel Administration or under the Director General of Railroads.

Science and War.

In a paper read recently at Chicago, Major R. A. Millikan, Professor of Physics in Chicago University, stated that war was 85 per cent science and engineering and 15 per cent actual fighting. As one application of science he mentioned that it had proved practicable to locate the position of a heavy gun within 50 ft. by observations on the sound waves set up on its discharge.

War Department Wants Engineers.

The War Department has asked the Brotherhood of Locomotive Engineers to furnish 50 men for tank service and 1,000 engineers for transportation service in France.

Saving Coal by Mixing

Interesting Experiments on the Lehigh Valley

The coal burned in Lehigh Valley Railroad engines is fast reducing by nearly 35 per cent, the consumption of coal, by a plan now working successfully and which gives evidence of proving a big saver. Not only does the new plan save the railroad one-third of what it has formerly spent for supply coal for its engines, but it releases just that much coal for other purposes and disposes of an accumulation of material in the anthracite regions which heretofore has been regarded as pure waste. The new plan provides for the crushing of bituminous coal and its mixture with anthracite silt, using two parts of the soft coal to one of silt. Silt or slush, as it is also called, has always been regarded as a useless bi-product of the anthracite industry. It is the dust which has passed through a mesh where the openings are no larger than three thirty-seconds of an inch in diameter.

LEHIGH VALLEY RAILROAD COAL TRAIN DRAWN BY LOCOMOTIVE USING MIXED PULVERIZED FUEL.

All over the anthracite fields there are great banks of silt. As far back as April, 1913, Mr. F. M. Chase, vice-president and general manager of the Lehigh Valley Coal Company, conceived the idea of utilizing the silt by a mixture with soft coal. He called in Mr. M. S. Hachita, a Japanese, the coal company's chemist, and outlined a series of experiments. An old boiler plant at a colliery near Hazleton, Pa., was rigged up for the use of the material mixed under Mr. Hachita's direction. He experimented with soft coal in lumps and also pulverized, and with varying mixtures together with silt. With the soft coal pulverized and a mixture of 70 per cent soft coal to 30 per cent silt, Mr. Hachita found that the resulting fuel produced exactly the same amount of water evaporation as when pure bituminous coal was used. He reported his experiments to be successful, but as the demands for coal were not as great then as now, the matter was not followed up as it might have been by the company.

The recent serious coal shortage and the greatly increased cost of bituminous coal brought the former successful experiments to the attention of Mr. E. E. Loomis, president of the Lehigh Valley Railroad. This time experiments were made with locomotives, particularly the big engines equipped with automatic stokers. Mr. H. B. Brown, manager of the fuel department of the railroad, joined in the experiments, which were made on the heavy engines which handle long trains of coal on the Mahanoy and Hazleton division. A mixing plant was erected at Hazleton, Pa., where the soft coal was crushed and mingled mechanically with the silt in the proper proportions.

The plan has proved successful. Trains of 50 cars loaded with coal were handled easily by engines fired with the mixed fuel and the investigators discovered that it produced 30 per cent more steam than the same quantity of ordinary bituminous coal. Additional mixing plants are now in process of erection at various points in the coal regions and the mixture will be quickly transported to all engine terminals and coaling points. The quantity of the silt, standing in great banks at every colliery, is estimated at millions of tons. The whole scheme has resulted in the very satisfactory saving of coal at a time when it means much to the railroad and to the country, and incidentally it helps the companies' finances.—It is all to the good. The Lehigh Valley Railroad gives 100 sq. ft. as the size of one of these grates with 37 per cent air opening through the bars.

Annual Report of the P. R. R.

The annual reports of the Pennsylvania Railroad Company are looked upon as an index of the business conditions of the entire country. The freight traffic during 1917 was over 60 per cent. greater than before the war. The passenger traffic exceeded that of 1916 by 10 per cent. In spite of all this the net income is less, chiefly on account of the increased price of material, the changing and training of new employees to fill the vacancies caused by 11,000 officers and employees entering the national service, and also by insufficient equipment due to manufacturing priority granted to the Government. The capital expenditures outlined for 1918 are to increase and enlarge the railroad equipment and terminal facilities to accommodate further the increasing traffic. The Chicago Union Station to be jointly used by the Pennsylvania and other systems is being continued in certain parts of the construction work. A notable example of the activity in the Pennsylvania may be gathered from the report of the work done at the company's shops at Altoona, Pa. In addition to extensive repair work during the year there were constructed at the Altoona shops 203 locomotives, 65 passenger cars and 2,346 freight cars. An example of increased cost in locomotive running is given. In 1917 the cost of repairs, depreciation, fuel, lubricants and engine house expense was $41.55 per 100 miles, as compared with $28.88 the previous year. The greatest advance was in fuel, which rose from $9.60 per 100 miles in 1916 to $18.15 in 1917.

Purchase of 20 Locomotives in the United States.

Consul General L. J. Keena reports from Valparaiso, according to a decree published, the Board of Directors of Railways is authorized to purchase 20 locomotives of the type in the United States.

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Men of the Bull-Dog Breed.

The Third Liberty Loan will be on the market for sale on Saturday, April 6, 1918. This loan is not a gift of money by the purchaser, but a paying investment, yielding interest at an adequate per cent, and fully redeemable in due time. The bond is negotiable any day. No one who purchases a bond will lose money. Contrast this satisfactory prospect with the outlook of those who have given their dear ones to the grave chances and the imminent hazards of war. Our fine young men, who have marched away are the flower of American stock. They may not be versed in reading political riddles, but they have answered the call of their country and have believed, with all the trusting reverence of youth, what you and others have told them, that our quarrel with the foe is just.

These brave, loved, loyal men must be clothed, fed, transported and ministered to. They must be given rifles, and ammunition more than sufficient for every need, they must be given cartridges and bullets so many and more yet, that the weapon they rely on may grow hot and smoke in the skillful hands that fire it, they must be given the sharp, gleaming bayonet, made of the finest steel, that it may not snap at the crucial moment in the hand that deals the blow, and that our men may not fail to strike, strong and true, for the great cause, and horrible though the work may be, beyond all telling, let our soldier boys have the means to fight fearlessly for the right, and stand with unsullied conscience before the searching eyes of God.

Those who honorably stay at home must help the Government by money, work, and strong resolve, to carry on the people's war, and to give our men the chance they need, and must have, if Victory is to rest with us, and it must be ours. The army is willing to fight, it must be made able to fight. Our people will be called on to make sacrifices, some of them already have, but nothing can approach the irreparable loss of a gallant life, nor soften the unassuaged human grief of those whose sons and brothers and husbands will not come back. This thought must be present and point to a duty, clear as the day, while there is yet time to act. This is no hour to count party gain. No government on earth is entirely free from mistakes. Did you ever think it was really praise to say of a man that he was a splendid hand at a railroad wreck. If his railroad gave him enough practice at clearing up each heavy smash, it is certain that his road was badly managed. The man to whom this wrecking work is always new, has been trained on a road where breakdowns and collisions are almost things unknown.

Major Guthrie, of the Canadian Army, with a record of one or two years of trench service, speaking recently at a gathering in New York, likened the struggle to the fight he once saw, between a British bull-dog and a collie. The dogs were unequally matched. The collie was large and powerful, covered with long, smooth, close hairs, and armed with clean, sharp, white teeth. The bull was small, bow-legged, with brindled hide, and a set, determined, ugly face. The bull-dog could get no hold on the long, smooth, coat of the collie and that dog attacked by a series of quick, cutting slashes and bites. Soon the bull-dog was bleeding profusely from every square inch of his cruelly lacerated back and sides. He seemed to have gained nothing but his wounds. Suddenly in one of the swift, slashing attacks, the bull-dog suffered, but Guthrie noticed that he had caught the end of one of the collie's paws in his teeth. Shaking or dragging the paw was useless, the bull-dog's hold was firm. The collie realizing this, grasped the bleeding form of his antagonist in his teeth and at the same time raising his imprisoned paw, hurled the bull-dog up in the air and thumped and battered him down to earth again. Bleeding, torn, almost stunned, blinded and flung fiercely about, the bull-dog held on, but his jaws took a fresh hold, an inch-and-a-half higher up on the collie's leg.

Again the struggling lift, the tearing flesh, and the cruel blow to earth. Quivering, with blood-shot eyes the creeping hold of the bull-dog advanced further up the leg. Again, and yet again, and though the punishment was ruthless and savage, the creeping grip at length showed on the collie's shoulder. We have seen, said Guthrie, the paw of the German wolf caught at Ypres, we have taken the hard, hard knocks and even the foul blows of war, but have kept the grip tight, each time going a little higher up, and please God, the next fierce clash of arms will see us at the throat of the German wolf.—Remember our boys are there, taking their part with our gallant allies; the tricolor of enduring France nearby. Our own star-flag above the Rainbow host we have sent, and beyond, the triple cross of fighting Britain that they call the Union Jack. The devices on each flag are different, but the colors are the same, we are all united and our colors stand to win.

Those who have to stay, can help on that cause, and can put strong means to win, within the eager grasp of our own army. It needs money to do it. This is not a territorial struggle, nor a mere dynastic clash, it is not the war of those who never fight. It is our war, our men are in it and our honor is at stake. The government at Washington is the constituted agent for waging our war and we must provide the means. Some years ago there was a rhyming triplet, meant to emphasize some strong position taken by Lord Beaconsfield, when he was premier of Great Britain. It ran thus: and it applies to us now:

"We don't want to fight—but by Jingo! if we do,
We've got the men, we've got the ships,
We've got the money too."

Liberty-loving Americans!—Anglo-Saxons by blood, by speech, and thought!!—Men of the Bull-Dog breed!!!—Make that last line ring true to the Government you have put in power, to carry on your war, to Victory, and to Peace.

Standardization Without Monopoly.

The open letter on page 104, addressed to the Hon. Wm. G. McAdoo, Director General of Railroads, by Mr. Geo. A. Post, president of the Railway Business Association, contains material for thought, not only for the governmental authorities, the former railroad managers who will one day have their railways in their hands again, but for the public at large.

Mr. Post realizes that a locomotive as it stands on the track today is the outcome of two classes of workers. The builders with their huge plants and thousands of workers, and the supply man with his specialty and the large body of employees concerned in its production. Extreme standardization, on the one hand, would tend to destroy industries legitimately reared under conditions that the Government made no sort of move to hamper or even modify in the past. Extreme

standardization would practically amount in this case to a form of monopoly. Extreme freedom in the production of all kinds of appliances, both useful and the reverse, has been automatically checked by the business and competitive restrictions imposed in the commercial world. Monopoly has been only given to any Government by the consent of the people. At present the postal department is the most complete, on earth. Nobody objects, and it is never for a moment conceived that the management of the post office will one day fall into the hands of private corporations.

Mr. Post sees the after-war condition as clearly as he perceives the present day tendency. He does not attempt, by his suggestion, to hamper the Government in rapidly obtaining large numbers of cars and engines, nor does he question the expediency of a suitable war measure. He rather defines the direction of aim, and by setting up a target for all to fire at, he hopes to see fewer shots go wild. The interchange of freight cars has, by economic and commonsense reasons, produced a form of standardization, which while it does not encourage monopoly, gains the end for which it exists, most thoroughly and efficiently.

Car interchange has given every manufacturer the right to design a coupler embodying his own ideas or his own experience as to strength, form of yoke, disposition of springs, etc., the only condition being that such coupler must readily unite with all other couplers, that the knuckles, coupler-head, etc., shall be of a definite prescribed size and of a pre-determined contour. This is standardization without monopoly, and it produces the uniformity desired, without destroying the individuality of the designer or hampering the judgment of the buyer. There is in this system enough freedom and enough competition, to induce good practice, with hardly a trace of restrictive action. If any burden exists, it is not felt.

The Railway Business Association thesis really favors an extension of the Master Car Builders' conception of a measured standardization, where practical hardship is eliminated. No one feels the sense of restriction, nor is legitimate competition stifled by the use of a definite, known size of wheels. It is to the skilful application of this kind of standardization to locomotive design or building, and the choice of means for particular uses, that the open letter advocates. It has much to recommend it, for it is already tried and it is practical. It has a minimum disturbing effect on present-day conditions, it will be as good after the war as it is now, and it does not call upon the Government to give up the essentials of a most desirable war measure.

Government experts or those employed in that capacity will find their ingenuity fully taxed in any case, but if, as we expect, the enlightened and conservative judgment of the Secretary of the Treasury and his advisers, prevails, there will be little fear that a judicious war measure will hamper the growth and expansion of legitimate industries, which add so much to the efficiency of locomotives and cars as they have heretofore been operated and it will facilitate the production of large numbers of engines and cars.

Whose Duty Is It?

In the published report of the Interstate Commerce Commission concerning the collision at Mount Union, Pa., which we quote in another column, page 111, the official opinion of that body is very fully and very authoritatively stated. The commission has taken into consideration the difficulties which enginemen have to encounter. The seeing of signals from the cab of a fast-moving engine is by no means a certainty, even at the best of times, the fact that the luminosity of a colored light may be observed a considerable time before the color is defined. That is to say, a man may see that he is looking at a light a long time before he can possibly tell whether it is red or green or yellow. This undoubted handicap on the man is still further weighted down by the fact that in day or night conditions, fog may further restrict observation, already difficult, and the many distractions which assail the mind of the observer, gives only a still narrower field to the man who is conscientiously trying to do his duty, and may practically block the way for intelligent vision and understanding for the man who is weary or not keen to do his work.

The commission does not mince words or obscure its meaning, when it says that some form of automatic device which will control the train and bring it to a stop, is most distinctly required. The object of such a precaution is primarily to preserve life. It may prevent property destruction and financial loss, but the plain, unvarnished truth is that man is an imperfect and unreliable machine, who has been wrongly expected to perform a service for which Nature has not specially fitted or trained him, and the heavy price exacted by Nature for the failure he is prone to, is death. In these days, when we are giving our sturdy, promising, rising manhood to the desperate hazard of war, we ought to protect the lives of those who honorably remain by every means in our power.

The stop signal is not a mere beautiful refinement of railroading. It is a necessity. The Interstate Commerce Commission says that to provide a stop signal is a duty, and no one in his senses dreams of opposing so open, so sure and so inviting a path to beneficial attainment of good results as the use of this form of automatic train control.

The commission declares that the good work, this necessary provision, is the duty of the railways. Granted that it is, who are now the "railways"? Manifestly, the Government, functioning through the Interstate Commerce Commission. It does not look like a complicated piece of reasoning to see that the properly constituted investigating body, competent to hear evidence and to pass judgment and to point out a clear duty to the railroads should at the moment it finds itself an intimate part of the "owning" power, holding and working the railroads in the public interest—it is not hard to realize that the duty still remains, and only the persons upon whom that duty now falls, have been changed. As well might a judge, in a criminal court, after trial, make a calm statement that the criminal before him was a burglar and that it was the duty of someone to punish him. The judge who finds him guilty pronounces sentence. If the providing of the stop signal is a duty, and the Commission says it is, it becomes the duty of the Commission to provide that signal or seek at once for power to do what it defines as a definite duty.

Tractive Effort and Adhesive Weight.

In the matter of tractive effort and horsepower and draw-bar pull, one more word may be said about these, and an also related subject, which is the part played by adhesive weight. But before speaking of it one may say that tractive power and draw-bar pull, although often taken as interchangeable terms, do not strictly stand for the same thing. The calculated tractive power is found by the use of the well-known formula applied with the dimensions of some particular engine. The draw-bar pull, or as some might say, the tractive effort is this tractive power, less the internal friction of the engine and tender.

The internal friction of the machine varies according to its make, size or in other ways, and is often taken at from 10 to 12 per cent. of the tractive power. Whether or not this is an accurate estimate is by no means certain, but may be conveniently used in the absence of more definite data. However, it is clear that tractive power is the theoretically calculated amount and draw-bar pull, or as some still call it, tractive effort is the power minus the friction of the machine. Power and Effort are here used distinctively, but there is no hard and fast rule on the subject and one will often find these terms used indiscriminately and often draw-bar pull is intended to be understood by the use of the same terms. Strictly, the two things are quite distinct.

Adhesive weight is the figure which represents the effective part of the weight when it comes to moving the engine along the track. When locomotive traction was first tried, cogwheels running on a rack

was thought to be necessary. Later on Hedley of "Puffing Billy" fame tried smooth wheels on a smooth track. He applied weights, one at a time, and found that with the engine heavy enough the smooth-tired wheels ran on the smooth rails without slip. The adhesive weight now considered requisite is, roughly speaking, about .25 of the total weight of the engine. If now the adhesive weight of an engine with smooth steel tires is in the neighborhood of one-quarter of the total weight, we have a good approximation to work with.

If we take this approximation as a working basis, we find that it has rather an incidental relation to the calculated tractive effort, and is not a part of the formula. If we find that an engine has a tractive effort, by calculation, of 40,000 lbs., our problem is a new one, then it is how this tractive effort can best be utilized. If the tractive effort is 40,000 lbs. we may suppose that the total weight of the engine, to get full service, is four times this amount, or 160,000 lbs. We wish to utilize the 40,000 lbs. advantageously. It will not do to put the engine at an angle of 45 degrees headed up an ice toboggan slide. If we did, the engine would slip and not climb the grade. Any other somewhat unadvantageous position would produce a like result, and we discover that we have not made full use of the 40,000 lbs. calculated tractive effort. If we weight down the engine excessively the wheels will turn with difficulty or not at all.

Mankind did not create or devise the co-efficient between steel tires and steel rail. That is one of the laws of Nature to which we must conform. Supposing, as we have here done, that this co-efficient of friction is .25, our problem is to make the best arrangement we can. For ordinary railway work, taking one thing with another, it is good practice to run the engine with smooth, steel tires on smooth, steel rails of suitable shape, and so proportion the total weight to the tractive effort as to produce the best result for the work we wish to do.

Trautwine gives the results of the Westinghouse-Galton tests in 1878 and 1879. The co-efficient of friction of a locomotive was found to be .33, but the experimental co-efficient of steel on steel is .15; an average drawn from these two gives .24, or, let us say, .25, and we find that the engine has a tractive effort approximately one-quarter of the total weight. Rail conditions vary from one day to another, so that for a switch engine having 40,000 lbs. tractive effort, in order to be sure of no slip—for the engine is constantly stopping and starting—we should make the engine heavier than the theoretical 160,000 lbs. Good American practice gives the factor of adhesion (which is the total weight divided by the tractive effort) as 4½ instead of just 4. The total weight of the switcher ought to be 180,000 lbs. in order to eliminate all chance of slip. For a road engine, by which is meant freight and passenger locomotives, the factor of adhesion is taken at 4¼, so that the road engine, to use satisfactorily the 40,000 lbs. tractive effort, should weigh 170,000 lbs.

A road engine, though not intended to slip, may yet give a little slip at the start with greater impunity than a switch engine should give, and the builders, knowing that when the engine in running normally will have a fine cut-off and use less steam, and so automatically reduce the tendency to slip, let it go at 4¼, while a yard engine working on long cut-off heavy steam pressure and slow speeds cannot be permitted to slip without loss of fuel, power and time. Speaking generally, the factor of adhesion may be taken at 4 theoretically. Road engine service (passenger and freight) require 4¼, and for yard engine service it takes at 4½.

"For God's Sake, Hurry Up."

These were the late Joseph H. Choate's last words to his fellow-countrymen. They applied to every particular of America's participation in the great war. They were the passionate appeal of a loyal citizen who loved his country, served it with distinction, and wished to see it fulfil its destiny worthily. Never was this appeal more in need of being answered with zeal than now. Time is the essence of a contract and ours is to help to free the world from the tyranny of autocracy. This is no time to "let George do it." Every citizen must help the work to which America is devoted.

These words of Mr. Choate are applicable to the remedial work to which America is also devoted in her effort to lessen the horrors of an unnecessarily brutal mode of warfare imposed upon the world by the German military autocracy. The Red Cross must "hurry up" if it is to save the lives of the wounded. The surgeon and nurse must "hurry up" if they would restore them to health, strength and future effectiveness. No calculated, theoretical card-indexed methods will avail where life hangs in the balance. And where the fate of a race depends on the prompt response to the "hurry up" call of a desperately menaced nation. There is but one answer, as Emerson finely says: "In all the worlds of God there is no escape but performance."

Such a "hurry up" call comes from the Near East, where for six centuries and more Armenians, Syrians and Greeks have been at the mercy of the brutal Turk whose natural savagery has been rendered systematically effective by the introduction of the Prussianized methods of so-called "German efficiency." In 1913 there were approximately 4,500,000 Armenians, Syrians and Greeks in Asia Minor, whose only crimes were that they were Christians, lovers of liberty, and successful in business. This roused the fanaticism and cupidity of the Turk who, as Sir Charles Eliot says, "does not know how to *make*, but only how to *take*, money." In 1918 only approximately 2,500,000 of these unfortunate peoples remain. The rest have been deported, despoiled, starved and massacred, until there is but this scanty remnant left to tell the tale. Like the 7,000 in Israel who refused to bow the knee to Baal, they are the "righteous remnant" that is the hope of the future Christian democracy of the Near East. They are in desperate need and from them daily comes, in the very words used by Mr. Choate, the cry, "for God's sake, hurry up."

During the past two years the American Committee for Armenian and Syrian Relief has raised the sum of $8,510,899.96 for the saving of these peoples. Large as eight millions of dollars seem, it is small for the work to be done. The best these millions have been able to do is to give 17 cents a day to every refugee who is fortunate enough to be able to reach a relief station. Thousands of others have died and thousands more are dying for the lack of even this pitiful dole. Every penny of this money has been spent in the actual work of relief. Not a cent has been diverted for the expenses of collecting or disbursing it. The overhead charges, in America and in the Near East, have all been met by the private and princely generosity of two New York gentlemen who prefer to remain unknown. The Turk has not interfered with the work of relief, probably because it relieves him from the burden created by his own cruelty. The money is expended on the spot for food. At least $5,000,000 a month is necessary to finance this work.

If these peoples are to realize the dream of freedom and liberty that they have so courageously fed their starved souls upon for six centuries of hope deferred, it will be because America now gives them bread to feed their poor bodies and save them from extermination. America has a large investment in and among the subject races of the Ottoman Empire. For 80 years almost all the missionary and educational work done there has been due to American faith and initiative.

Unless America gives a prompt and generous answer to this "hurry" call, not only will these defenseless, and now desperate but courageous peoples starve to death and the world will be worse off because of it, but America herself will lose the approval of its own conscience that comes from a great duty well done, therefore, for the sake of America as well as for the sake of Armenia, we re-echo and reiterate the appeal of the great American, who being dead yet speaketh: "For God's sake, hurry up."

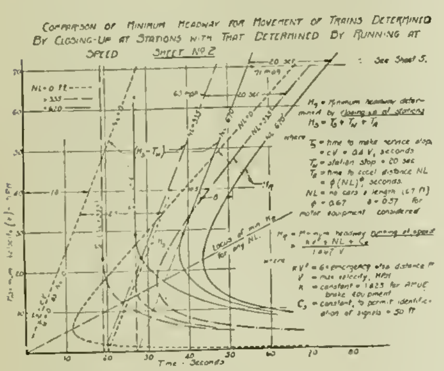
Air Brake Department

Relation of Modern Brake Apparatus to the Spacing of Trains in Congested Districts

By WALTER V. TURNER, Assistant Manager, Westinghouse Air Brake Co.

Referring to the remarks recently made on the above named subject, it will be remembered that the entire object and the diagrams used, was to illustrate how closely trains could be run with safety when equipped with modern, electrically operated air brake apparatus. The diagrams shown here will serve to make this somewhat clearer and indicate how the spacing of a system of trains is scientifically accomplished with a view of utilizing the traffic capacity of a railroad to its fullest possible measure.

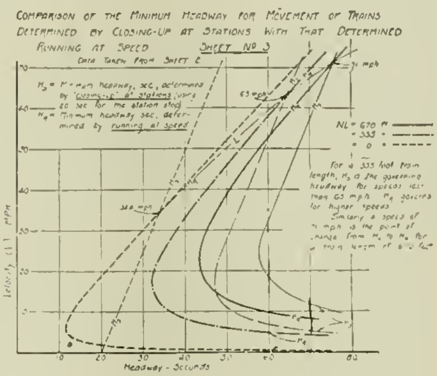
Sheets 2, 3 and 4 give a more detailed analysis of the relation between headways Hs and Hr previously mentioned. Sheet No. 2 gives a complete development of the various factors which go to make up the two kinds of headway. The time for accelerating different train lengths is given by the formula, and some of the bases in the way of braking distances, and



Detailed analysis and comparison of the two methods of figuring headway; one based upon "closing up" at stations, and the other upon "running at speed."

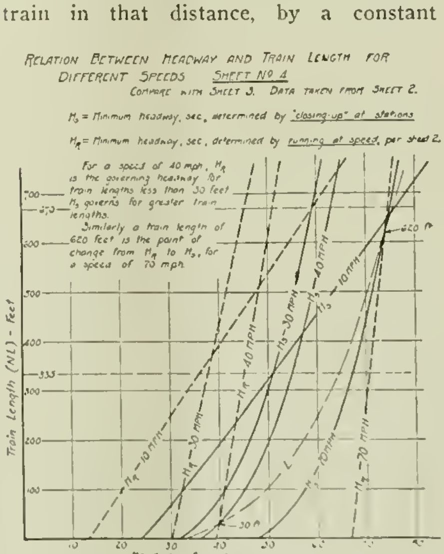
time, appear in the previous issue already referred to.

Sheet No. 3, is a summary of the results obtained from sheet 1, and the heavy lines represent the "running" headway (Hr) and the light lines the "station" headway (Hs). The dotted lines are for zero train lengths; the dot and dash lines for a train length of 335 ft.; and the full lines for a train 670 ft. long. Curves for zero train lengths are given to show what the limiting conditions are when a train is considered as a point only. Curve L gives all points where, for any train length, Hr equals Hs; that is, it relates the speeds and these equal headways for any train length. Thus for a 335-ft. train length Hs is greater than Hr, and will, therefore, be the governing headway for all speeds under 63 miles an hour. At that speed the two headway curves cross and mutually indicate a headway of about 64 seconds. Above this speed, Hr is the greater and must therefore be the governing headway.



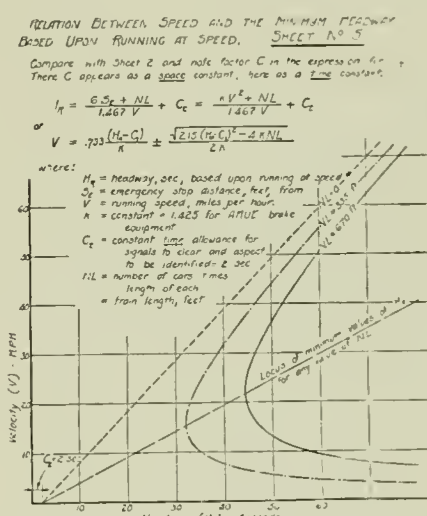
Summary of the results. For speeds below a critical value (which is higher as the train length is increased) the headway based upon "closing-up" at stations will be larger and therefore the determining value for the spacing of trains.

Sheet 4 gives the relation between the train length and the headway for various speeds. The dotted lines show the variation of running headway with the train length, and similarly the full lines for the station headway. As the speed is higher, the dotted lines become more and more erect, showing that the train length becomes of decreasing relative importance for the higher speeds, that is, a change in train length effects the running headway less as the speed becomes higher. Not so with the station headway, however, for a change in train length naturally affects the time to accelerate the train in that distance, by a constant



The running headway will determine the spacing of trains for train lengths less than a certain critical value (which is greater as the speed is higher).

amount, unless the speed be lower than that ordinarily attained by the train at the time it has accelerated a distance equal to its length. Under such a condition, after the train has attained it, this speed must be continued for the rest of the train length, which of course, lengthens the time for the train to move from rest a distance equal to its own length. This explains why as the speed decreases below a certain critical point, the curves for Hs (sheet 3) and for (Hs-Tw) sheet 2, turn to the right, indicating increasing headways for decreasing speeds. For a train of zero length, the time to accelerate the distance is, of course, also zero, and therefore the Hs curve for this length of train does not swerve to the right, but



The allowance for signals to clear and for enginemen to identify their indication may be taken in terms of distance or of time. This shows the result where the allowance is made in *time*. Fig. 18 makes the allowance in *distance*. This applies only to "running" headway, of course.

continues to decrease with decreasing speeds.

Curve L on sheet 4, is the locus of all points where Hs, and Hr, are equal; that is, Hs and Hr are both equal to 74 seconds for a train length of 620 ft. and a speed of 70 miles an hour. Curve L joins all such points. The two curves L sheets 3 and 4, taken in conjunction with the other curves, describe in a very complete manner, the relative jurisdiction of the two headways, the running and the station, as to the point where one takes precedence over the other. They reveal that improvements in the way of higher rates of acceleration, reduced time of station stops, and higher maximum speeds will cause the running headway to be the determining factor over a wider range of

train operation in the way of increasing train lengths. Improvements in brake effectiveness (higher rates of retardation), though they may affect both service and emergency braking in the same proportion, will nevertheless reduce the "running" headway to a much greater extent than they will the "station" headway, because of the former's larger dependence upon the braking factor. These improvements in braking will therefore have an effect opposite to the above, by making the station headway the determining factor over a wider range of train operation in the way of increasing speeds and longer trains. An isolated example appeared in connection with the diagrams shown last month where an initial delay of 5 seconds to the train was multiplied into a final delay of 18 seconds. By "initial" delay is meant the difference between the time a train passes a certain spot at the lowest speed to which it has had to slow down, and the time it would have taken to pass this spot if it had continued at maximum speed. Thus, if a complete stop is made from a speed of 40 miles an hour in 18 seconds, (a retardation of about 10 per cent) the initial time lost is not 18 seconds, but only 9, for it will take the train 9 seconds time to traverse the stop distance if travelling at full speed. If it requires 40 seconds time to return from rest to full speed at a uniform acceleration of one mile an hour per second, the delay this occasions is not 40 seconds, but 20, for it takes 20 seconds to traverse the acceleration distance at full speed. The total delay to this train is then, for an initial delay of 9 seconds (which just brings it to a stop), 20 + 9 or 29 seconds; that is, the initial delay of 9 seconds is little over three times. The time the train remains at rest is added, of course, to the initial and final delay also. In the following issue of RAILWAY AND LOCOMOTIVE ENGINEERING this subject will be continued.

Locomotive Air Brake Inspection.

(Continued from page 89, March, 1918.)

266. Q.—How can the dirt usually be removed?

A.—By making a heavy service reduction, closing the brake valve cut-out cock and returning the valve handle to running position?

267. Q.—What if the cut-out cock is in the reservoir pipe?

A.—Make the same brake valve movement without closing the cock.

268. Q.—What will this usually do?

A.—Blow the dirt from the piston and its seat.

268½. Q.—What if it does not?

A.—The piston needs grinding in on its seat.

269. Q.—Can the equalizing piston packing ring of a brake valve be tested by placing the brake valve on lap position and opening an angle cock if the brake is of the retarded application type?

A.—No.

270. Q.—Why not?

A.—Because these brake valves usually have the collapsible type of equalizing piston.

271. Q.—How does this piston act under this condition?

A.—It collapses and discharges the equalizing reservoir pressure into the brake pipe.

272. Q.—What is this type of piston intended for?

A.—For keeping the brake pipe and equalizing reservoir pressures within 2 or 3 lbs. of each other during a two-application stop with a passenger train.

273. Q.—How can you then tell the difference in these valves without taking a brake valve apart?

A.—By handling the brake valve as though the equalizing piston packing ring was to be tested for leakage by opening an angle cock with the brake valve on lap position.

274. Q.—Is there anything else that could cause a too rapid reduction in the equalizing reservoir or rather in the chamber above the equalizing piston?

A.—Yes, a partial stoppage in the restricted port in the gauge pipe tee.

275. Q.—How can this usually be detected?

A.—By a sharp hard exhaust from the brake valve exhaust port when the equalizing piston lifts.

276. Q.—How can this be distinguished from a sticky equalizing piston that would also cause a sharp heavy exhaust?

A.—If the port in the tee is restricted the piston will usually lift instantly, but if the sharp exhaust is due to a sticky piston, the piston will not lift promptly or until about 5 lbs. or more, reduction is made in the equalizing reservoir pressure.

277. Q.—Will the collapsible type of piston act in the same manner?

A.—Yes.

278. Q.—What could be wrong with a collapsible piston if it would not lift at all during a service reduction?

A.—The spring between the piston and stem might be broken or the piston and stem might be stuck together or "collapsed."

279. Q.—What is the size of the brake exhaust port of a brake valve when there is an exhaust pipe leading from it to the double heading cock?

A.—Seven thirty-seconds of an inch.

280. Q.—What is the size with the Westinghouse Standard arrangement?

A.—One-fourth of an inch.

281. Q.—What is the size of brake pipe exhaust ports on engines not equipped with the E. T. brake?

A.—Nine thirty-secondths of an inch.

282. Q.—Why is this difference?

A.—To compensate for the difference or manner in which the brake pipe pressure is discharged through the fittings.

283. Q.—Explain this more fully?

A.—When the exhaust is practically straight away from the brake valve, as with the exhaust pipe leading through the cut-out cock, the smallest or 7-32 opening is used. Where the air is discharged at one right angle turn, as with the standard arrangement, the opening is ¼ in. Where two turns are made at right angles as with the G-6 brake valves, the opening is 9-32.

284. Q.—What is the difference in the rate of brake pipe discharged with the different arrangements?

A.—There is none of any consequence the rate of discharge is practically the same, the larger size of openings merely compensates for the restriction of frictional resistance encountered through the flow of air pressure through the elbows.

285. Q.—About how much additional resistance to the flow of air is encountered when an elbow is added to a length of pipe?

A.—Every elbow is equal to about 15 additional feet of pipe from the view of frictional resistance to the flow of air through the pipe.

286. Q.—Can you determine the size of the brake pipe exhaust port during an inspection of the locomotive brake?

A.—No, it cannot be determined without an examination, that is by disconnecting the exhaust pipe or screwing the exhaust fitting out of the brake valve and measuring it.

287. Q.—How can this exhaust pipe between the brake valve and reservoir cut out be tested for leakage?

A.—By closing the brake valve cut-out cock and making a service application.

288. Q.—Why?

A.—Because the brake valve exhaust port is at this time closed by the key of the cut-out cock.

289. Q.—What is the effect of too large a brake pipe exhaust opening?

A.—It tends to discharge brake pipe pressure from a train at too rapid a rate, thereby contributing to undesired quick-action.

290. Q.—What is to be done after the pressure is reduced from 110 to 90 lbs. in from 5½ to 6 seconds time during the inspection?

A.—The brake valve handle is to be returned to holding position.

291. Q.—Why?

A.—To see that there is no leakage in the release pipe branch between the brake valves and to see that the feed valve returns the gauge hands promptly to 110 lbs.

292. Q.—Why must the feed valve return the black gauge hands promptly to 110 lbs.?

A.—To prove that there is no obstruction to the flow of air through the feed valve pipe or the ports in the brake valve leading to and from the feed valve.

293. Q.—What would be the effect of leakage in the release pipe branch at this time?

A.—It would cause the brake to release.

294. Q.—What is the next brake valve movement to be made?

A.—The automatic brake valve handle is returned to running position and the independent valve placed in slow application position.

295. Q.—How long should it take to obtain 40 lbs. brake cylinder pressure with the independent valve in slow application position?

A.—From 6 to 8 seconds.

296. Q.—What should the final pressure be?

A.—Same as that shown on the test coupler when the signal whistle was tested.

297. Q.—Why are the last few pounds obtained at a slower rate?

A.—Because the pressure in the reducing valve pipe and the application cylinder pipe are almost equal and the flow of air through the slow application which is necessarily slower when the pressures are almost equal.

298. Q.—What portions of the air gauges are being tested by this brake valve movement?

A.—The red hand of the No. 2 air gauge.

299. Q.—How so?

A.—By comparing the final brake cylinder pressure with that shown on the test coupler when the signal whistle was tested.

300. Q.—Is this always reliable?

A.—No. but it is reliable enough for practical purposes.

301. Q.—In what way is the test not reliable?

A.—Considerable friction in the application portion of the distributing valve would create a difference in the pressure in the brake cylinders and that in the application cylinder and signal system.

302. Q.—How can this be determined?

A.—By the next movement of the brake valve.

303. Q.—What movement is this?

A.—Graduating the independent brake off by alternating the valve handle between lap and running positions.

304. Q.—How does this have any bearing upon the sensitiveness of the application portion of the distributing valve?

A.—If the application portion is sufficiently sensitive, the brake can be graduated off about 5 lbs. pressure from the brake cylinders at a time.

305. Q.—What action will result if the valve is not sufficiently sensitive?

A.—The drop in brake cylinder pressure cannot be made in this manner in less than 8 or 10 lbs. at a time.

306. Q.—Should such disorders be reported?

A.—Yes.

307. Q.—Why?

A.—Because the more sensitive the brake is to operation, the smoother the stop that can be made with it, or rather the more sensitive the parts of the brake equipment, the more flexible it is.

(To be continued)

Train Handling.

(Continued from page 90, March, 1918.)

288. Q.—How is the brake valve handled on the last brake application at the foot of the grade?

A.—The brake pipe pressure is reduced below the adjustment of the feed valve and the brake valve handle then moved to release and running position.

289. Q.—Would it be necessary to carry the brake valve handle in release position in descending moderate grades?

A.—No. In some instances the valve handle is carried in running position while the brakes are recharging when descending long heavy grades.

290. Q.—Why is it that air brake men will not attempt to lay down any fixed rules for handling brakes on trains?

A.—In order to state just how any train may be handled the most advantageously necessitates a thorough understanding of every operation of the brakes and a knowledge of the condition of practically every brake in the train, as well as having an intimate knowledge of every local circumstance as to track conditions, grades, curves and location of signals.

291. Q.—How does passenger train braking differ from freight train braking?

A.—Passenger train handling demands a smooth and accurate stop, but a shorter brake pipe, consequently less brake pipe volume permits of more rapid movements of the brake valve handle for different requirements, and gives a more prompt and uniform response of the brakes.

292. Q.—In coupling to a passenger train, is the operation of the governor the same as in coupling to an uncharged freight train?

A.—The operation of the governor is the same, but the train is usually charged from a yard test plant, or at division points, the train is left practically charged by the inbound road engine.

293. Q.—In what position is the brake valve handle when coupling to a passenger train?

A.—It is allowed to remain in running position.

294. Q.—Why?

A.—So that there will be no application of the brakes when the hose are united and on hurried movement the brakes will be ready for test as soon as hose have been coupled.

295 Q.—After the train is solid and signal to apply brakes for test is given, how much of a brake pipe reduction should be made?

A.—Twenty-five pounds for PM equipment and not less than 30 lbs. for LN equipment.

296. Q.—How is the signal to apply given?

A.—Either by verbal request, or four blasts of the signal whistle or by hand signal.

297. Q.—How is the signal to release given?

A.—By four blasts of the signal whistle transmitted from the rear car of the train.

298. Q.—Is the brake test then complete?

A.—Not until after the inspector or trainman announces the condition of brakes, number of cars and number of operative brakes in train.

299. Q.—Who is responsible for securing this information?

A.—Both the conductor and engineman.

300. Q.—What per cent of the brakes must be in operative condition?

A.—Not less than 85 per cent.

301. Q.—How is a release of brakes made in passenger service?

A.—By moving the valve handle to release position and promptly back to running position.

302. Q.—Why promptly back to running position?

A.—To prevent the possibility of an overcharge of the reservoirs on the head end of the train.

303. Q.—Why is it not necessary to leave the handle in release position as long as with a freight train?

A.—Because the brake pipe is shorter and the increase of pressure in the brake pipe throughout is more rapid.

304. Q.—After leaving the station, where will the first application of the brake take place?

A.—At the first opportunity, when the speed is high enough to permit of a 12-lb. brake pipe reduction.

305. Q.—What kind of a test is this?

A.—A running test of brakes.

306. Q.—Made for what purpose?

A.—To know that all angle cocks are open and that the brakes are holding.

307. Q.—How is the independent brake valve handled during this application?

A.—It is held in release position while the 12-lb. brake pipe reduction is being made.

308. Q.—Why?

A.—To know that the retarding effect is from the car brakes and not from the powerful brake on the locomotive.

309. Q.—Why is it necessary to make such a heavy reduction?

A.—To insure a satisfactory release of brakes.

310. Q.—Is it necessary to make this 12-lb. application in one reduction?

A.—No, it can be split up into two 6-lb. reductions.

311. Q.—Why is a light brake pipe reduction liable to result in stuck brakes?

A.—Because of the difference in pressure obtained between the auxiliary reservoir and the brake pipe as governed by

the proper adjustment of the feed valve.

312. Q.—Explain this more clearly?

A.—A triple valve may be in a condition to require a differential of from 5 to 6 lbs. in pressure to accomplish a release, and with a 6 or 7 lb. brake pipe reduction the necessary difference may not be obtained, whereas if the difference between the pressure in the auxiliary reservoir after the brake application and the adjustment of the feed valve is as much as 10 or 12 lbs. the triple valve will release promptly.

313. Q.—Would this not indicate that the brake valve handle might be left in release position for more than one second?

A.—No, with the large capacity air compressors, and different types of car brake operating valves especial care must be taken to see that the brake pipe pressure must not exceed the adjustment of the feed valve, or if it does during the release, it must be but momentary.

314. Q.—What if the brake pipe pressure happens to be far below the adjustment of the brake pipe feed valve?

A.—The handle may be left in release position until the brake pipe pressure is very near the adjustment of the feed valve.

315. Q.—With low pressure in the brake pipe and the handle in release position, what may you be considered to be doing?

A.—Charging the train.

316. Q.—What position of the brake valve is to be used for charging the train?

A.—Release position, same as for charging a freight train.

317. Q.—Before considering the handling of passenger trains at high speeds, what brake valve manipulation should first be understood?

A.—The successful handling of passenger trains at low speeds.

318. Q.—For what purpose?

A.—To determine how a train can be stopped smoothly, so that there will be no damage to equipment, or complaints from passengers.

319. Q.—When shifting cars of a passenger train, is it permissible to move cars with the air hose uncoupled?

A.—Not on dining cars, or any cars that are occupied by passengers.

320. Q.—When shifting empty cars with the air hose between engine and cars uncoupled, is it permissible to use the independent brake valve in quick application position?

A.—Only in cases of emergency.

321. Q.—When applying the independent brake under such conditions, how much brake cylinder pressure should be developed from the first movement of the independent valve to application position?

A.—Not over 8 or 10 lbs.

322. Q.—Why not more?

A.—To prevent a harsh application of the engine brake.

323. Q.—How should the brake then be applied?

A.—It should be graduated on same as if used in freight service.

324. Q.—What is the idea?

A.—To take up the slack or let it run out gently.

325. Q.—How should the independent brake be released under such a shifting condition?

A.—It should be graduated off.

326. Q.—What is meant by graduating the brake off?

A.—To allow the brake cylinder pressure to escape about 5 lbs. at a time.

327. Q.—How does this assist in a smooth stop if the engine is moving ahead and the cars at the rear of the engine are crowding against the engine?

A.—It relieves the tension of the draft springs or the compression of them gradually instead of causing a sudden shock by releasing the tension almost instantly.

328. Q.—Considering modern types of passenger car brake equipments, such as the L. N. P. C. and U. C., how is the brake valve handled if the engine and two or more cars are coupled to several uncharged cars and a prompt movement is desired?

A.—The brake valve is moved to service position and about 30 lbs. brake pipe reduction made before the hose between the cars can be coupled.

(To be continued)

Car Brake Inspection.

(Continued from page 91, March, 1918.)

281. Q.—How is the piston travel maintained on a passenger car?

A.—By means of an automatic slack adjuster.

282. Q.—It will be assumed that the operation of the brake slack adjuster is understood, which way does the ratchet move to take up slack?

A.—To the right, or in the direction of the adjuster cylinder.

283. Q.—How is slack secured in the brake rigging for the application of new brake shoes?

A.—By turning the adjuster screw in the opposite direction from the adjuster cylinder.

284. Q.—Why is the slack not taken out by means of the truck levers?

A.—For the reason that moving the adjuster screw is the easiest method, and the positions of the truck levers or pinholes should not be changed.

285. Q.—Why not?

A.—For the reason that if the foundation brake gear is correct in design, and the slack adjuster screw was all the way out, and the piston travel adjusted to 6 ins. standing travel when new brake shoes were previously applied, there should never be any occasion to change the positions of the brake levers when applying brake shoes.

286. Q.—What should be done after the brake shoe is renewed?

A.—The brake should be applied and the piston travel measured.

287. Q.—What should be done if the piston travel is too long?

A.—The slack should be taken up with the adjuster screw.

288. Q.—Suppose that the travel is one inch too long, can you take up one inch with the adjuster screw and know that it is an inch?

A.—Yes, if the screw is moved away from the cylinder one inch, the piston travel will be taken up one inch.

289. Q.—What should be done if through improper adjustment the slack adjuster is found to have the cross-head drawn up the full limit where no more slack can be taken out of the rigging?

A.—If possible an entire new set of shoes should be applied, and the adjuster screw let out all of the way and the piston travel adjusted by means of the truck levers.

290. Q.—What if the adjuster screw will not turn to allow the cross-head to be screwed back against the cylinder end of the adjuster?

A.—It means that the pawl is engaged with the ratchet, therefore the stop screw at the end of the adjuster would be slacked off enough to allow the pawl to become disengaged.

291. Q.—What should then be done before any other move is made?

A.—The stop screw or set screw should be securely tightened in its place. Two wrenches should be used in locking the stop screw.

292. Q.—What might result if this was forgotten?

A.—The screw might be lost and if the adjusted screw was again fouled, it would be necessary to take the adjuster apart in order to release the pawl from the ratchet.

293. Q.—What would happen if a wrench was used to move the ratchet and screw while the pawl was engaged?

A.—Some of the teeth would be broken out of the ratchet.

294. Q.—What attention should an adjuster receive.

A.—It should be cleaned and oiled every time the brake cylinder receives this attention.

295. Q.—Should oil or grease be used to lubricate the adjuster screw?

A.—No, it merely collects dirt and causes the adjuster screw to become galled.

296. Q.—What should be used as a lubricant?

A.—Dry graphite.

297. Q.—Should the brake be cut out if the adjuster operating pipe is found broken off and repairs cannot be made at the time?

A.—No. Some of the slack in the rigging can be taken up by hand so that the car can run to some point where repairs

can be made.

298. Q.—What will taking up by hand do?

A.—Prevent the brake cylinder leather from passing the port leading to the adjuster pipe.

299. Q.—Where is the adjuster pipe to the brake cylinder usually located in the cylinders?

A.—About 8⅜ inches from the pressure head.

300. Q.—To what running travel does it regulate the piston?

A.—Eight inches.

301. Q.—Why is it that where adjusters are working properly, the standing travel on a car with the single shoe brake gear is not more than 6 inches?

A.—It means that the difference between running and standing travel is about 2 inches, that is, that two more inches of piston travel are obtained when the brake is applied on the car when running.

302. Q.—What equipment on the car is required to change the quick action automatic brake to a high speed brake?

A.—A high speed reducing valve is attached to the brake cylinder.

303. Q.—How is this equipment generally designated?

A.—As the PM equipment.

304. Q.—What brake cylinder pressure dose the high speed reducing valve maintain?

A.—60 lbs. per square inch.

305. Q.—How is the high speed reducing valve adjusted?

A.—By attaching an air gauge to the brake cylinder.

306. Q.—What if there is no provision for attaching a gauge to the brake cylinder?

A.—The gauge may be attached to the reducing valve at the pipe plug opposite of the brake cylinder pipe connection.

307. Q.—What connection could be made if this plug could not be readily removed?

A.—The gauge may be attached to the auxiliary reservoir and the brake applied by exhausting all of the air from the brake pipe.

308. Q.—Why would the auxiliary reservoir pressure then be the same as that in the brake cylinder when the brake was fully applied?

A.—Because the triple valve then provides a direct communication between the auxiliary reservoir and the brake cylinder.

309. Q.—With 70 lbs. pressure in the auxiliary reservoir, and with 8 ins. brake cylinder piston travel, what will the brake cylinder and auxiliary reservoir equalize at?

A.—At 50 lbs. pressure.

310. Q.—With 90 lbs. pressure in the auxiliary reservoir?

A.—About 65 lbs.

311. Q.—With 110 lbs. in the auxiliary?

A.—About 80 lbs.

(To be continued)

Electrification of the Railroads

At the convention of the American Institute of Electrical Engineers, held in New York recently, President E. W. Rice, Jr., in the course of his opening address, said that where electricity has been substituted for steam in the operation of railroads, fully 50 per cent increase in available capacity in existing tracks and other facilities has been demonstrated. This increased capacity has been due to a variety of causes, but largely to the increased reliability and capacity, under all conditions of service, of electric locomotives, thus permitting a speeding up of train schedules by some 25 per cent, under average conditions. Of course, under the paralyzing conditions which prevail in extremely cold weather, when the steam locomotives practically go out of business, the electric locomotives make an even better showing. It is well known that extreme cold (aside from the physical condition of the traffic rail) does not hinder the operation of the electric locomotive but actually increases its hauling capacity. At a time when the steam locomotive is using up all its energy by radiation from its boiler and engine into the atmosphere, with the result that practically no useful power is available to move the train, the electric locomotive is operating under its most efficient conditions and may even work at a greater load than in warm weather. It may, therefore, be said that cold weather offers no terrors to an electrified road, but on the contrary, it is a stimulant to better performance instead of a cause of prostration and paralysis.

But this is not all. It is estimated that something like 150,000,000 tons of coal were consumed by the railroads in the year 1917. Now we know from the results obtained from such electrical operation of railroads as we already have in this country that it would be possible to save at least two-thirds of this coal, if electric locomotives were substituted for the present steam locomotives. On this basis there would be a saving of over 100,000,000 tons of coal in one year.

The possible use of water should also be considered in this connection. It is estimated that there is not less than 25,000,000 H. P. of water available in the United States, and if this were developed and could be used in driving our railroads, each horsepower so used would save at least six lbs. of coal per horsepower hour now burned under the boilers of our steam locomotives. It is true that this water power is not uniformly distributed in the districts where the railroad requirements are greatest but the possibilities indicated by the figures are so impressive as to justify careful examination as to the extent to which water power could be so employed and the amount of coal which could be saved by its use. There is no doubt that a very considerable portion of the coal now wastefully used by the railroads could be released to the great and lasting advantage of the country.

Our water-falls constitute potential wealth which can only be truly conserved by development and use—millions of horsepower are running to waste every day, which once harnessed for the benefit of mankind become a perpetual source of wealth and prosperity.

In the Middle and Eastern States, however, water powers are not sufficient and it will be necessary in a universal scheme of electrification that the locomotives be operated from steam turbine stations, but as I have already stated, the operation of the electrified railroads from steam turbine stations will result in the saving of two-thirds of the coal now employed for equivalent tonnage movement by steam locomotives.

Electrification of railroads has progressed with relative slowness during these many years, waiting upon the development and perfection of all of the processes of generation and transmission and of the perfection of the electric locomotive itself. When all these elements had been perfected, as they now have been, for several years, the railroads found themselves without the necessary capital to make the investment.

I realize that the task of electrifying all of the railroads of the country is one of tremendous proportions. It would require under the best conditions many years to complete and demand the expenditure of billions of dollars.

It is not necessary that electrification should be universal in order to obtain much of its benefits. It is probable that one of the most serious limitations of our transportation system, at least in so far as the supply of coal is concerned, is to be found in the mountainous districts and it is precisely in such situations that electrification has demonstrated its greatest value. Electrification of a railroad in a mountainous district will in the worst cases enable double the amount of traffic to be moved over existing tracks and grades.

If a general scheme of electrification were decided upon, the natural procedure would be, therefore, to electrify those portions of the steam railroads which will show the greatest results and give the greatest relief from existing congestion. Electrification of such sections of the steam railroads would have an immediate and beneficial effect upon the entire transportation system of the country and it is our belief that electrification offers the quickest, best and most efficient solution that is to be obtained.

Ten Powerful Baldwin Westinghouse Electric Passenger Locomotives for the Chicago, Milwaukee & St. Paul Railway

Twin Motor Design with Quill Drive

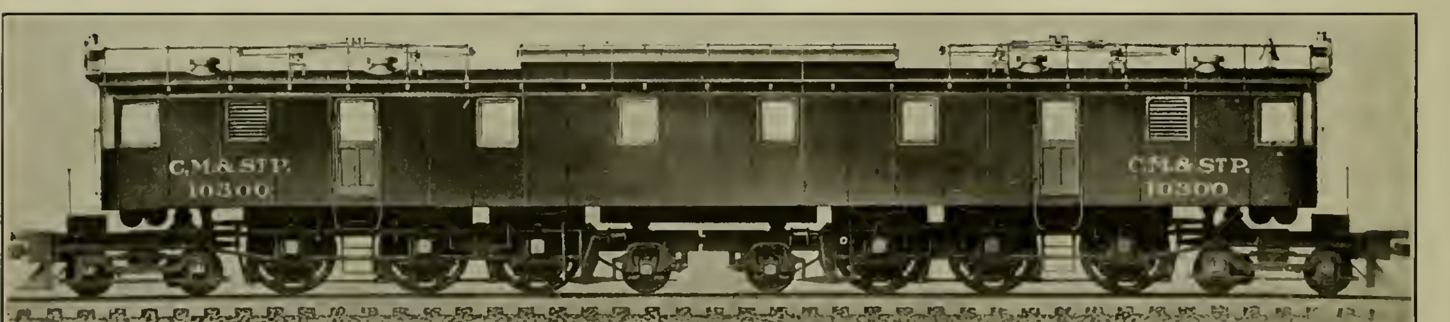
The concentration of enormous horsepower in a single locomotive has long been the recognized tendency in railway practice, originating from considerations of economy and the greater efficiency of large units. Further increase in size will yield small improvement in efficiency. Recourse must be had to some new form of motive power if the necessary gain in hauling capacity is to be made. On the Chicago, Milwaukee & St. Paul Railway, its use over the 440 miles of line and over the Rocky Mountains has been so satisfactory in cutting power costs, hauling heavier trains and keeping traffic moving in all weathers that the railroad's decision has recently been made to electrify another mountain division—the two hundred and eleven miles from Othello, Wash., over the Cascade Range to Seattle and Tacoma. With the completion of this work, a distance equal to that from New York to Cleveland, will be under electrical operation. To handle passenger traffic over this and the Rocky Mountain division, the St. Paul has ordered ten Baldwin-Westinghouse electric locomotives.

The complete locomotive has a total length over couplings of 90 ft.; weight ready for service, 266 tons, with an adhesive weight of 330,000 lbs. Following the modern tendency in design toward conservation of weight and space, these new locomotives will be single-cab units, although the horsepower capacity is much greater than for any double-cab engines now in service. The cab is carried on the two main running gears, each having a four-wheel guiding truck, three driving axles in a 16 ft. 9 ins. rigid wheel base, and a two-wheel trailing truck. It thus corresponds to two Pacific-type running gears coupled with a link and having two-wheel trucks on the adjacent ends. The center pins are located midway between the first and second driving axles of each running gear. On one running gear the center pin is designed to restrain the cab both longitudinally and laterally, while on the other running gear, the center pin restrains the cab only laterally, permitting free longitudinal movement. This arrangement of riding and floating pins relieves the cab of all pulling and buffing strains due to train load, as these strains are taken directly through the running gear side frames and bumpers.

The driving wheels are 68 ins. in diameter, and carry 55,000 lbs. on each axle. The guiding trucks have 36-in. wheels, while the two-wheel trucks each have a load of 38,500 lbs. at the rail, with approximately 63,000 lbs. distributed on each of the four-wheel trucks. On any single driving wheel the non-spring supported weight is that of the wheels, axles and driving boxes only.

The flexible type of quill drive used affords a means of permitting a motor located well above the roadbed to drive an axle which, with its wheels, is free to follow the rail independently. It is evident that this drive secures all the advantages of a flexible gear in cushioning the transmittal of the torque and it avoids the road shock far more effectively than with the common flexible gear construction and mounting. Each main running gear has three-point equalization with a single point toward the end of the locomotive, in accordance with accepted steam locomotive practice. The four-wheel guiding truck center-pin and cross-equalized leading pair of driving wheels are equalized together on the longitudinal center line of the locomotive. This wheel arrangement combines all the advantages of the standard front end construction of the American and Consolidation types of steam locomotives. The two remaining pairs of driving wheels and the two trailing wheels of the main running gear are side-equalized together, thus following accepted steam-locomotive practice.

The center of gravity of the main running gear, including motors, is 41½ ins. above the rail, and the height of the center of gravity of the complete locomotive is 63 ins. above the rail. Among the novel features which will be found in these locomotives are: Large capacity in single-cab unit. Flexibility of running speeds with small rheostatic losses. Twin motor design with quill-drive. Low-voltage auxiliaries simplifying inspection, maintenance, and operation. Simple and effective regeneration. Improved equalization to minimize weight transfer in trucks. Auxiliary train-heating plant.



NEW ELECTRIC LOCOMOTIVE FOR THE CHICAGO, MILWAUKEE & ST. PAUL.

H. R. Warnock, Gen'l S. M. P. Builders, Baldwin-Westinghouse

These will probably be the most powerful locomotives running in passenger service. A single locomotive is able to haul a 950-ton train (12 coaches) over the entire mountain section at the same speeds as are called for by the present schedules. The one-hour rating for one of these locomotives is 4,000 h. p., and its continuous rating is 3,200 h. p., with a starting tractive effort of 112,000 lbs. The normal speed on the level track is 60 m. p. h.; on a 2 per cent grade it is about 25 m. p. h. One of the noteworthy characteristics of these machines, which is very desirable in passenger service, but which has not heretofore been attained with this type of electric locomotives, except at the expense of heavy rheostatic losses, is the flexibility of running speeds.

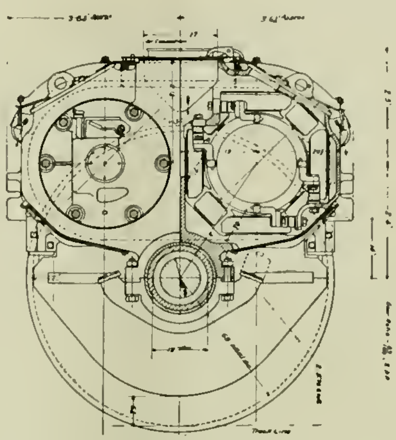
There are nine running positions without rheostatic loss. This is accomplished by the use of six 1,500-volt twin motors

on the locomotive, arranged for three-speed combinations as follows: Position No. 1, 1 set 6 motors in series; No. 2, 2 sets 3 motors in series; No. 3, 3 sets 2 motors in series. During the change from one speed combination to another, the tractive effort is maintained. Two additional running speeds are obtained on each speed combination by means of inductive shunts on the main motor fields, which assist in cutting down current peaks as well as saving rheostatic losses, thus enabling the power demand over the varying profile to be kept more nearly constant. The speed range is from 8 to 56 m. p. h., depending on the load.

The use of the twin motor design with quill drive not only permits the most effective use of space between the driving wheels, but enables the use of two armatures, each wound for 750 volts direct current, and geared to the same quill. This also makes possible the advantage of better commutating characteristics inherent in the lower voltage motors. Low voltage auxiliaries considerably reduce the complication and hazard of high voltage on these locomotives. The only high voltage apparatus among the auxiliaries is the motor of the small motor-generator which is used for train lighting and charging the storage battery. The resultant simplification secured by the use of low voltage appliances decreases the complication of installation, maintenance and operation. Ordinary inspection can be carried on, including the functioning of switches and auxiliaries, with the complete absence of 3,000-volt power on the locomotive.

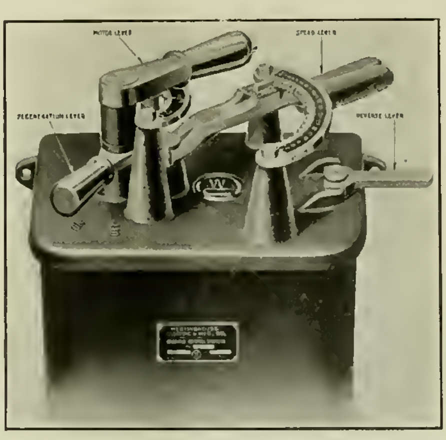
The use of regenerative control for holding trains on descending grades is such an important function in these locomotives that special arrangements have been perfected to secure positive operation of this feature over widely varying speeds. The same main motor combinations for "motoring" are used for "regenerating" except that the fields of the main motors are separately excited over a wide range by axle-driven generators. These are so connected with balancing resistance that inherent stability in the motor characteristics during regeneration is assured, irrespective of whether the changes in line voltage are sudden or gradual. With the regenerative braking of trains lessens the duty on the air brake equipment, further safety in braking with electric engines is introduced with the axle-driven generators. These machines are mounted on the pony trucks of the locomotive, and in addition to exciting the motors during regeneration, furnish the power for operating the air compressors and blower motors when the locomotive is hauling. This method insures a current supply to the air compressor motors irrespective of the overhead trolley supply, and provides that compressed air will always be available for use of the air brakes.

In electric locomotives without connected wheels, weight transfer due to tractive effort is an important thing. This is caused by the drawbar-pull being exerted at the coupler height, which, with the reaction at the rail, tends to lift the leading end and depress the trailing end. This changes the weight distribution and increases the tendency of the wheels to slip. The method of equalization described above reduces the weight variation on the driving wheels to only 6 per cent from normal, when pulling at 30 per cent adhesion, as is possible with electric locomotives owing to the steady and gradually increasing torque of the machine.



TWIN MOTOR WITH QUILL DRIVE.

The question of passenger train heating is of vital importance due to extreme weather conditions encountered in that section of the country. Heat must be assured under all conditions of failure of equipment, and delays of trains. The heating plant, therefore, must be entirely independent of the electrification. Each locomotive is equipped with an oil-fired steam boiler, designed to burn ordinary fuel oil used by the railway company. Provision is made for a storage of 7,500 gallons of water and 750 gallons of oil in each engine.



CONTROLLER FOR C. M. & ST. P. ELECTRIC LOCOMOTIVE.

The careful attention which has been given to improve the details of design and operation of these new engines, it is hoped, will mark an epoch in the development of the electric locomotive, and make it an important factor in the transportation problem of this country.

At a recent meeting of the New York Railroad Club, diagrams of these engines were shown, and comparisons were made with existing electric locomotives. The fact that the tractive effort of the machines delivered at draw bar level has a tendency to tilt the frames and to alter the adhesive weight on the wheels was clearly brought out. We intend to offer some explanation of this phenomenon in a subsequent issue of RAILWAY AND LOCOMOTIVE ENGINEERING.

The fact that an electric locomotive driving the wheels from a jack shaft with connecting rod accurately balanced, and turning the driving wheels, having only side rods, does away with all the troubles incident to the dynamic augment, was also made plain at this meeting. It is possible to balance such driving gear for all speeds as the torque of the motor is constant and no disturbances due to reciprocating motion can take place as the reciprocating parts are entirely absent.

Pile Driving with Locomotive Cranes.

Experiments have shown that the regular standard locomotive crane may be provided with an entirely separate and independent attachment, quickly connected to its boom, that immediately provides rigid leads in which either a steam hammer or a drop hammer can be installed and the whole made adjustable for driving long piles in perpendicular or inclined positions at any point within a long radius from the stationary machine and, by moving the machine under its own locomotive gear, at any point on either side of the track within the boom reach. In such a case the drop hammer can be handled by the regular boom hoisting tackle or the same tackle can handle the steam hammer in the leads and the hammer can be supplied with steam from the regular boiler operating the locomotive crane. An additional whip line can easily be rigged enabling the locomotive crane to handle the piles and place them in the leads with the important advantage of being able to swing around and pick them up from the rear or even to travel back and get them when necessary.

Such a tool possesses great flexibility and is almost universally applicable for a wide variety of standard operations making it available in one shape or another for many of the most important operations that a general contractor encounters in heavy construction work and eliminating the initial cost, installation, and transportation of a number of separate machines that would be required to do the same work.

Facilities for Locomotive Repairs

At a meeting of the Canadian Railway Club held last month, E. R. Battley, master mechanic of the Grand Trunk Railway, Montreal, read a paper on "Locomotive Repairs," giving interesting details on the methods in vogue on the Grand Trunk, and emphasized the need of keeping up the repairs on the motive power. To do this, Mr. Battley stated that it was absolutely necessary to provide proper facilities for repairing and handling, at roundhouses and general repair shops. He stated that it is difficult to do quick work at terminals unless we provide proper facilities, such as suitable roundhouses and equipment. The key to the power handling situation of the roundhouses is the ashpit, therefore, we must provide large pits equipped with a sure and quick means of handling the accumulation of cinders. Ample room must be provided on both sides of the pit so that in rush hours fires can be cleaned or dumped and engines moved along out of the way to await their turn on the turntable. If this space is not provided, and after an engine or two has been dumped, it means the work on the engines following is at a standstill until those ahead have been moved. Conditions of this kind causes ashpit gangs to be idle and at a busy terminal a large waiting list is the result.

In close relation to the ashpit is the turntable and shop leads. The former should be of rigid construction and power operated. The leads should be of sufficient length to accommodate outgoing engines and provided with suitable crossovers and water-cranes to facilitate the despatching of power.

A valuable addition to any roundhouse is good machinery. A great mistake sometimes made by railroads is filling up roundhouse machine shops with antiquated tools. When a machine job is required in a back shop it is usually a rush order, therefore speed and accuracy is required. If modern tools are used you get what is desired without delay. All our terminals of importance have been equipped with portable oxy-acetylene welding and cutting outfits, and needless to say they have proved invaluable.

Organization is another valuable asset to the shop. One may have a splendid layout, good tools, etc., but without system efficiency is reduced. We have found by arranging our roundhouse staff in special gangs good results have been obtained. These gangs are grouped as follows: Passenger, freight and switch, spring and brake gear, rod and box packing, lighting up, and last but not least, the hostler gang. The different gangs are controlled by charge men, who report to the shop foreman.

Engineers upon arrival record the necessary work in a book provided for that purpose. A competent inspector also makes an examination of the engine and records defects found. The work to be done is then copied by a man assigned to this work, who distributes the slips to the respective charge hands. When the work is completed a notation is made in the report book on the opposite page to the one on which the engineer placed his report.

During the busy season, when locomotives are at a premium, the cripples at roundhouses accumulate quickly, unless a close check is kept on the shipment of repair parts. We have a system of checking up and forwarding repair parts to out stations that has proved very satisfactory, and has been the means of keeping our locomotives in service during the past severe winter. Foremen at each station send a joint message to the Road and Shop Master Mechanics as soon as he finds he requires repair parts. In addition to this he sends in a daily report of engines undergoing repairs which will take over 24 hours, stating when engine was taken out of service, what material is required and on whom ordered. This gives the master mechanic an excellent opportunity of keeping in close touch with the situation on his division. To ensure requisitions being filled promptly and to avoid delays in shipment or at transfer points a "material" man was appointed by the road master mechanic. His duties are to check requisitions, receive telegrams for material, consult shop master mechanics and subordinates as to when material can be secured, see that there is no delay in handling, also advise out stations on what train material is going forward so that he can be prepared to have it removed promptly on arrival.

General repair shops should be of sufficient size to care for the power assigned to the division and centrally located. When an engine is to be placed in the shop for repairs the nature and extent of the repairs is mainly controlled by the master mechanic. Any unusual repairs may be decided upon after a boiler inspection and hydrostatic test has been applied. After the engine has been stripped the shop inspector makes out a final report and repairs are made accordingly. Accompanying each engine to the shop is the Locomotive Foreman's report of repairs which forms the basis from which shop Master Mechanic works.

There is approximately 10 per cent. of our power under repairs at all times. This is necessary to keep our engines in good condition, and also provides sufficient work in advance for the shop staff, who work entirely on the bonus system. Our output and bonus system are so closely related that in speaking of one it is necessary to mention the other. The subject tonight being repairs, the bonus system will only be mentioned when necessary to show why we handle certain operations in certain ways.

Taking it for granted that the various repairs have been made and are now in the erecting shop, it may be stated that this department was formerly handled with nine regular gangs, consisting of approximately ten men per gang, controlled by a chargehand who was responsible for three pits. In addition to the nine gangs we had three or four special gangs, such as shoe and wedge, guide bar, and steampipe. Our regular pit gangs carried the engine through from the time the engine was stripped, with the exception of the detailed work above mentioned. Under this system we accomplished good work until our forces became depleted through enlistments, and upon looking carefully into the situation we found where a gang usually had five or six mechanics it would now have one or two, the remainder being unskilled help. It was, therefore, necessary for us to meet the new conditions in order to keep up the repairs. To do this we rearranged our men into special gangs, mainly to centralize our machinists on work that really required mechanics, and use the unskilled labor on the coarser work. With this arrangement instead of a gang having three pits on which to work they have the entire erecting shop, therefore delays were reduced to a minimum.

Referring to the bonus system, there is one special feature of this system which is the key to the success of that system; that is, the demonstrating end of the bonus department. The prices set by demonstration, when possible, are known to be fair and correct. The chief demonstrator and his assistants have charge of this work over the entire system, and travel continuously from shop to shop. These men do not bother a great deal about prices, as this has been efficiently handled by the bonus department of each shop, which sets the prices according to the peculiar conditions surrounding the different plants, but being our most expert men they concentrate their efforts in bringing each department in all shops to a higher state of efficiency by transferring best methods, and, if necessary, men from one shop to another. As a result of this method workmen are free from worry of price cutting, therefore, the standard of work has shown a steady improvement. This department also controls the method of applying the bonus system, with the result that the method of application is the same at all shops. It is needless to say the results obtained from this system have been highly satisfactory, and in spite of the unfavorable labor conditions, we have maintained repairs on our locomotives, and in addition to keeping up the ordinary repairs we have been able to convert 57 engines from saturated to superheated steam.

Electrical Department

No-Voltage Control as Used in Railway Equipment
The Portable Railway Sub-Station

Last month there was an article on page 84 referring to the no voltage control for shop machinery and a description of the methods used for AC and DC motors was given on page 93. As pointed out, the object of the no-voltage release, in connection with machine tools, is to afford protection to the workman in case the power is shut off unknown to him.

There is used, in connection with railway equipment on subway and elevated cars, a no-voltage relay which is to cause a certain function to go into effect, independent of the motorman in case of a failure of the voltage. The object is not to protect the motorman in the case of the failure of voltage, but to protect the apparatus and give satisfactory operation of the equipment.

The conditions are somewhat different than in the case of the operation of shop machines in this way, that power may be broken from the car itself, although there is no failure of power to the third rail. The cutting off of power from the cars themselves may occur many times during the trip. There are along the subway and elevated roadbed many cross-overs, so that it is impossible to lay a continuous third rail, although third rail shoes are carried on either truck and on both sides, still the "gaps" are considerably in excess of the distance between the shoes on one car. This means that current is broken to the car while passing through or over such a gap. While normally on straight tracks, the length of time required for a car to pass through a gap may be very short, a considerable time may elapse when the train is operating over a cross-over or along a ladder track, so that a considerable decrease in speed may result. With several cars in a train it would be almost next to impossible for the motorman to throw on and off the controller at the head of the train, so as to match up with the various cars entering and leaving the gap. Therefore the controller is left full on, so that an automatic feature must be installed which will allow each car to function by itself, depending on whether it is in contact with the third rail or not, and thus preventing surging between cars in the same train.

As mentioned above, the no voltage relay drops out the electrical switches on each car as it passes through the gap in the third rail, and when power is again on the third rail shoes, the switches come in. The rapidity in the closing of the switches will depend upon the speed of the car when the shoes come into contact with the third rail. On long gaps or cross-overs, the speed may fall considerably and a longer time will elapse for the switches to come in than if the gap was short. In the latter case, the sequence of the operation will be the same but they will follow each other as rapidly as they can operate. There will be no retardation or pause between steps, which is the case if the speed of the train falls off to a low value.

To explain why this is so let us refer to Fig. 1. In addition to the no-voltage relay, there is a limit switch so-called, which limits the amount of current which can flow into each motor and which determines the rate of acceleration of the car depending on its setting. The no voltage relay consists of a large number of turns of small wire wound on a spool, this coil being connected across (one end to the 600 volts, the other end to ground). We know that a current of small value will flow through this coil as this circuit is of high resistance. The flow of the current causes magnetization of the plunger which passes through the core

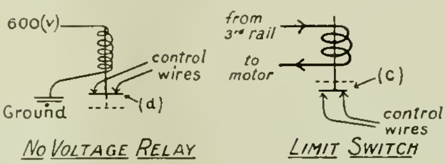


FIG. 1.

of the coil, and the plunger is drawn upward. On the bottom of this plunger is a small circular disc (d) which when in the up position, connects together a pair of control wires. These control wires must be connected together to keep the switches in the operating position. When the third rail shoes leave the third rail there will be no current flowing through the no voltage relay coil, and the plunger will drop due to gravity, thus breaking the contact of the two control wires and the disc thus opening up (as explained above) the electrical switches. On application of current to the car, the coil is again energized, the disc is drawn up, the control wires are connected together again, and the switches come in.

The speed of the switches coming in, depends on the speed of the car at the time it gets the power, and this is governed by the limit switch. The limit switch, in principle, is a relay, but the plunger is operated from the current flowing through a few turns of heavy copper strap which carries current for a single motor. This limit switch operates and controls the switches when the car starts from a stand-still. The motorman throws the master controller handle to the full-on running position. The plunger in the limit switch is loaded so that its weight will require a certain amount of current through the coil, before it will raise. Immediately after the master controller handle is thrown on, there is a flow of current to the motor, the plunger raises breaking the contacts on the disc (c) opening up the control wires and preventing further progress of the switches. We know that as an electric motor speeds up that the current value falls due to the back electromotive force increasing with the speed. When the current falls to a certain value, the plunger is heavier than the magnetic pull and it falls. Contact is again made on the control wires, and another switch comes in, which cuts out a step of resistance; more current flows to the motor, the plunger is drawn up again and is held until the motor speeds up, and the current value falls. This is repeated for each step of the resistance until the switches are all in.

It can be readily seen and understood that if the train was running say at ten miles an hour, when the current was connected, that the back electromotive force of the motor would be such that several steps among the switches would have to occur, before sufficient current would pass through the limit switch coil to raise the plunger and prevent further progression of the switches. If the speed was fifteen miles an hour, more switches would come in before progression would be stopped; and if twenty miles an hour were obtained, all of the switches could come in without the current value exceeding the picking up value for the limit switch. This explains why there may be a retardation of the switches if the speed drops to a sufficiently low value while there would be no retardation if the gaps were short.

This automatic feature is the no-voltage relay which in a way is exactly similar to the no-voltage release or control described in the previous issue of this magazine, for machine tool operation. It is a relay connected across the third rail voltage with power on the car, that is, when the third rail shoes are in contact with the third rail. The operation of the control switches is governed by the operation of the master controller at the head end of the train and operated by the motorman. When the master controller

is on, the switches are in. When it is thrown off, the switches open and the power is disconnected from the motors and the train is then coasting. When the master controller is on and the switches are closed, the no-voltage relay plays no part. Let us suppose the train takes a cross-over or passes through a gap. When the voltage is disconnected from the car due to the third rail shoes leaving the third rail, there is no longer any energy to hold the no-voltage relay in its operating position and the relay dropping out causes the switches which connect the power to the motors to open and this car is in the off position, although the motorman has not thrown off the controller. As soon as the current is again connected to the car, due to the third rail shoes coming in contact again with the third rail, the no-voltage relay rises and the switches come in step by step in the same sequence and order as if the motorman had thrown off the controller and notched it up again.

This no-voltage relay therefore makes each car automatic, in action, resulting in perfectly smooth operation of the train through the gaps, cross-covers, etc., and it is quite imperceptible to the passengers.

The Portable Railroad Sub-Station.

In our previous articles we have been discussing the design and construction of the railway sub-station and have described in detail the automatic sub-station. There is another type of sub-station which is of considerable interest which is known as the "portable sub-station." As the name implies, it is a sub-station which can be moved from place to place. For convenience, the complete sub-station apparatus is mounted on railroad trucks so that it can be transported over the road.

The portable sub-station has been in successful operation on a number of electric railways throughout the country, and the universal experience has been that a portable sub-station is always worth considerably more than what it costs. Below are a few of the uses which can be made of the sub-station of this type.

First—It constitutes a spare equipment for practically any number of sub-stations and renders unnecessary the installation of spare equipment in each. A railway load is generally irregular and sustains maximum peaks during rush hours or abnormal load conditions. Spare rotaries and equipment are usually mounted in each sub-station so as to care for the over-load condition, or to be used in case of emergency where one machine may be out of commission on account of trouble or out of commission on account of inspection and over-hauling. A portable sub-station which can be moved from one sub-station to another would be available for the furnishing of power in case of emergency conditions and it would be possible to use this portable sub-station as the spare equipment for the entire system.

Secondly—It can be used to increase the capacity of a permanent sub-station when the load is unusually heavy. There may be times, due to abnormal traffic, when the load on one particular sub-station would be exceptionally severe and greater than the capacity of a permanent sub-station. By locating the portable sub-station close to the permanent one the abnormal load can be taken care of and no consideration given to the power requirements which would be necessary if the portable station was not available. In other words, with only the permanent station furnishing power, the size and spacing of the electric train would have to be regulated so as not to cause a power demand greater than the capacity of the sub-station, and undoubtedly this arrangement would be far below the maximum traffic that could be handled.

Thirdly—It can be used for determining the most advantageous point at which to locate a permanent sub-station. This use needs hardly any explanation. With the growth in traffic, it may be necessary to build a new sub-station, and the most suitable location from an electrical standpoint can be determined by the cut and try method; that is, by locating the portable sub-station at two or three different points and comparing results. It can also be used to provide service while a permanent sub-station is being over-hauled or re-built, and it can be used (inverted) to test any cable and in transmitting energy round a break when a high tension line is being repaired. Normally, the sub-station receives the high tension current, transmitting it to direct current at approximately 600 volts. By "inverted" we mean that direct current is fed to the rotary and alternating current is generated which, when connected to the transformer, is stepped up to high voltage alternating current. When used in this way, high voltage alternating current is available for testing purposes.

Fourthly—It can be made a telling argument in promoting the sale of electric power, as it can be drawn to the desired point and there arranged to carry the load for a trial period to demonstrate the advantages of purchased power.

High voltage alternating current is of course required for the operation of the portable sub-station and it can therefore only be used where the high voltage is available. In railway work, power is supplied from a central station and the high voltage is transmitted from this station to the various sub-stations. Since the railway owns the right-of-way, it is most economical to run the high voltage wires on their own right-of-way, and these high tension wires are generally strung along the top of the poles which carry the other service wires for the operation of the road. Generally there are high tension wires throughout the whole right-of-way, so that practically the portable sub-station can be used at any desired point. The direct current from the portable sub-station can be made available very quickly, as its production involves only the transferring of the sub-station and its connections to the high tension line.

The general view of one of these sub-stations is shown in Fig. 1. The whole is mounted on a railroad flat car of M. C. B. standard type, so that it can be moved over any road. A sectional elevation is shown in Fig. 2. The weight and dimensions are a minimum. All of the "live" parts are carefully protected, so that the danger of accidental contact is minimized. A study of the Figs. 1 and 2 will show that the high tension voltage is not taken into the cab. The high voltage, switching and protective apparatus is mounted out of the way on the roof of the car. While these switches are on the outside they are controlled from a switchboard mounted directly underneath, by means of a remote control handle. The transformer is mounted directly over the truck at the uncovered end of the car. This arrangement is perfectly feasible, as

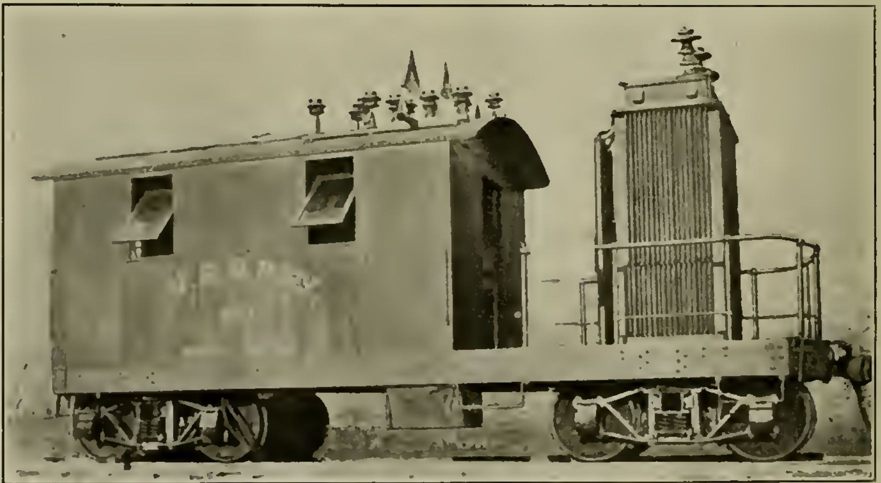


FIG. 1. ELECTRIC POWER SUB-STATION PORTABLE.

it is an easy matter to construct transformers for outdoor service where exposure to the rain, snow, etc., does not interfere with its satisfactory operation. The rotary converter and switchboard, however, are placed inside of the cab.

A very convenient and satisfactory method for opening and closing the high tension current is by means of the air-break Burke type of switch. The switches,

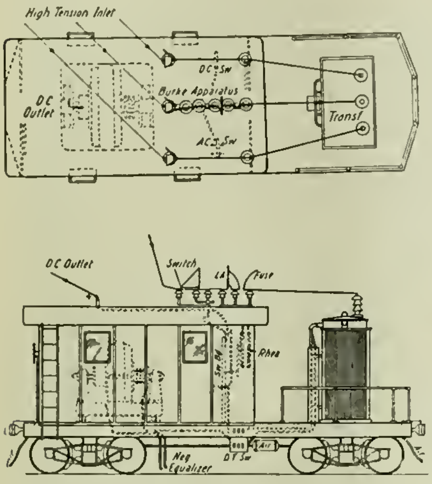


FIG. 2. PLAN AND SECTIONAL VIEWS OF PORTABLE SUB-STATION.

as mentioned above, are controlled from the inside of the cab. Referring to Fig. 3, it may be noted that on the top of the switch, which is mounted on the insulators, is a pair of horns. The arrangement is such that the contact is made and broken on the horns while the switch itself is closed, the horns being shunted by the blade. In opening, the horns stay in

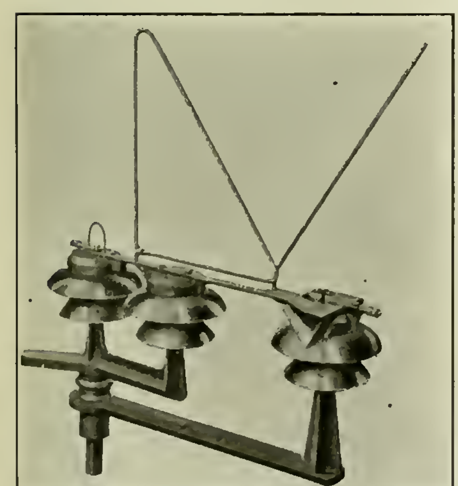


FIG. 3. BURKE AIR-BREAK HORN SWITCH.

contact until after the blade is clear of the jaw, then they open and the arc is taken on the horns and extinguished thereon. In the permanent sub-station usually the old circuit-breaker is used, the oil extinguishing the arc which it forms when the contacts are opened. In the case of the horn gap, the arc starts at the point A, but quickly rises due to the heat. On rising, the distance between the end of the arc becomes greater and greater; the arc being "drawn out," so to speak. On reaching the end of the horns, points BB, the ends of the arc can extend no further, but the center does, and finally breaks, at which time the flow of current is disrupted. Due to the careful design, portable sub-stations of 500 KW. capacity for alternating current voltages up to 44,000 have been built and are in use.

Importance of the Superheater Damper.

One of the most important requirements in obtaining the full effectiveness of a superheater is the proper operation of the damper and its rigging. From time to time attention has been called to the damage done and the failures caused by reason of plugged flues, leaky steam joints and other troubles which affect the steaming of a locomotive, and attention has been called to the fact that these conditions reduce superheat. Little has, however, been said about the trouble arising from a damper working improperly. It may be just as detrimental to locomotive performance as any of the things already mentioned.

The damper controls the draft and, therefore, the flow of gases through the large flues. It is placed just below the bottom row of large flues, usually on the same level with the table plate, and is operated by a small cylinder bolted on the side of the smoke-box. This cylinder is connected either to the steam pipe or blower, as the case may be, by a ½-in. copper pipe, and works automatically upon the opening of the throttle or blower valve. This operation opens the damper which is held in the closed position by a counterweight when the throttle is closed. The damper, as thus operated, protects the superheater units from overheating when there is no steam passing through them. Failure of the damper to operate properly, materially reduces the steaming capacity of the boiler and, consequently, reduces the degree of superheat. For instance, if the damper failed to open, it would obstruct the passage of gases through the tubes and flues above it, thus considerably reducing the boiler evaporation and preventing the effective superheating of the steam passing through the units.

It is also bad practice to wire up or block open the damper. If the damper is kept open continuously it is equivalent to having no damper at all. The firebox gases passing through the large flues and around the units when no steam is in them are very likely to burn the ends, warp the units and cause leaks, and generally shorten the life of the units. Enginemen have been kown to deliberately tie up the damper although it had proved to be in working condition when the engine left the engine house. Enginehouse employees have been known to do the same thing when firing up and it is just such practices as these that lead to engine failures.

One may say that dampers and rigging should be given a careful inspection at frequent intervals. This requires but little time to do. One of the first things to assecrtain is whether the damper closes tightly and, also, whether it has its proper opening. Search for irregularities. See that the damper cylinder piston has a full stroke and be particular to see that the connecting link between the damper shaft and the cylinder arm is of the correct length and that there is no lost motion in any part of the rigging that would tend to prevent full opening or closing. Keep the small copper steam pipe leading from the steam chest or steam pipe to the damper cylinder well protected against the effects of cold weather. This can readily be done by wrapping it with ¼-in. asbestos rope and covering that with canvas. See that there are no pockets in this pipe where water can accumulate and freeze. Drain from the damper cylinder to the exhaust passage of the locomotive cylinders by the use of a pipe, and cover it in the same manner as the steam pipe is covered. See that the cylinder and the connections in the rigging are lubricated. Paint the counterweight white so that it is easily visible to the enginemen. If the damper cylinder is so located that the counterweight is not visible, use a small target of any description on the counterweight arm and place it above the running board where it can easily be seen. An indicator of some kind is invaluable.

Bring home to the enginemen that the correct functioning of the damper is essential if the hands on the steam gauge and pyrometer are to indicate the correct steam pressure and temperature, because the proper steaming of the locomotive depends largely on the proper action of the damper.

Removal.

We have to announce the change of address of the Buffalo Brake Beam Company. They have moved from 30 Pine street, New York, to the Mutual Life Insurance Building, 32 Nassau street, New York. All communications should now be addressed to their new offices. This well known firm are the manufacturers of Buffalo Truss Beams; Buffalo Truss Beams with adjustable heads; Buffalo I-Beams, brake beams; Buffalo special rolled section brake beams, and brake beam forgings, etc.

New Regiment of Engineers.

Col. Frederick Mears, formerly a member of the Alaskan Engineering Commission, is organizing the Thirty-first Regiment of Engineers. Recruiting offices are being established at various points.

Items of Personal Interest

Mr. F. W. Fritchey has been appointed superintendent of shops of the Wheeling & Lake Erie, with office at Brewster, O.

Mr. G. O. Huckett has been appointed master mechanic of the Chicago, Burlington & Quincy, with office at Alliance, Nebr.

Mr. Arthur Grohm has been appointed general master mechanic of the Missouri, Kansas & Texas, with headquarters at Denison, Tex.

Mr. T. D. Sedwick, formerly acting engineer of tests of the Chicago, Rock Island & Pacific, has been appointed engineer of tests, with office at Chicago, Ill.

Mr. W. C. Davis has been appointed road foreman of engines of the Shasta division of the Southern Pacific, with office at Dunsmuir, Cal., succeeding Mr. R. W. Cuvellier.

Mr. J. M. Wood has been appointed foreman of freight car repairs of the Georgia Southern & Florida, with office at Macon, Ga.

Mr. A. G. Saunders has been appointed master car repairer of the Tucson division of the Southern Pacific, with office at Tucson, Ariz.

Mr. J. T. Slavin has been appointed assistant master mechanic of the Coast division of the Southern Pacific, with office at San Francisco, Cal., succeeding Mr. H. H. Carrick.

Mr. E. C. Rudloff has been appointed foreman of the car department of the Missouri, Kansas & Texas, with office at Denison, Tex., succeeding Mr. W. H. Macon, transferred.

Mr. J. H. Phillips, formerly traveling engineer on the Chicago, Milwaukee & St. Paul, has been appointed division master mechanic of the Northern division, with office at Horicon, Wis.

Mr. P. D. Miller, formerly assistant division engineer of the Pennsylvania, with office at Cambridge, Ohio, has been transferred to Toledo, Ohio, succeeding Mr. Howard O'Brien, resigned.

Mr. F. F. Gaines, formerly superintendent of motive power of the Central of Georgia, has accepted an appointment on the staff of Mr. C. H. Markham, regional railroad director, with office at Atlanta, Ga.

Mr. W. A. Randon has been appointed master mechanic of the first division of the Denver and Rio Grande with office at Pueblo, Colo., and Mr. W. C. Stevens has been appointed superintendent of shop at Burnham.

Mr. E. H. Mattingly, formerly car foreman of the Baltimore & Ohio, at South Orange, Ill., has been appointed general car foreman of the Chicago district of the Baltimore & Ohio, and the Baltimore & Ohio Chicago Terminal railroads.

Mr. G. B. Herrington has been assigned as supervising engineer of the Tucson division of the Southern Pacific, with headquarters at Tucson, Ariz., and will have charge of all matters pertaining to maintenance of way and structures.

Mr. H. T. Bentley, superintendent of motive power and machinery of the Chicago & Northwestern, has been requested to join the staff of the director-general of railroads at Washington, D. C. Mr. Bentley has obtained leave of absence for an indefinite period.

Mr. Charles Raitt, formerly general foreman of the car department of the Atchison, Topeka & Santa Fe, at Richmond, Cal., has been appointed master mechanic of the Arizona division, with office at Needles, Cal., succeeding Mr. L. A. Mattimore, deceased.

LOYALL A. OSBORNE.

Mr. E. E. Adams, formerly consulting engineer, and Mr. F. Sercombe, formerly assistant controller of the Union Pacific, have been appointed assistants to Mr. R. S. Lovett, director of the division of capital expenditure of the United States Railroad Administration at Washington.

Mr. N. W. Appleton, formerly general master mechanic of the Canadian Government Railways, has been appointed superintendent of motive power with office at Moncton, N. B., and Mr. W. E. Barnes, formerly master mechanic at Moncton, succeeds Mr. Appleton as general master mechanic.

Mr. R. E. Grieve has been appointed assistant road foreman of engines on the Pitsburgh division of the Pennsylvania, with office at Derby, Pa., succeeding Mr. Franklin Mowry, assigned to other duties; and Mr. H. S. Gentzel has been appointed assistant road foreman of engines, with headquarters at East Altoona, Pa.

Mr. W. F. Ackerman, formerly shop superintendent of the Chicago, Burlington & Quincy, has been appointed acting superintendent of motive power, lines west, succeeding Mr. T. Roope, on leave of absence; and Mr. G. E. Johnson has been appointed assistant superintendent of motive power, with office at Lincoln, Neb.

Mr. Daniel Willard, president of the Baltimore and Ohio, has been re-elected chairman of the Advisory Commission of the Council of National Defense. Mr. W. S. Gifford and Mr. Grosvenor B. Clarkson continue as director and secretary, respectively, of the commission, as well as director and secretary of the Council of National Defense.

Mr. J. L. Fagan, formerly master mechanic of the Denver and Rio Grande with office at Grand Junction, Colo., has been appointed master mechanic of the fourth division with office at Alamosa, Colo., and Mr. F. T. Owens, formerly assistant master mechanic at Pueblo, has been appointed master mechanic at Grand Junction, succeeding Mr. Fagan.

Mr. V. N. Polts has been appointed general foreman of the locomotive department of the Chicago, Rock Island & Pacific, with office at Liberal, Kan., and Mr. H. W. Burkheimer, formerly assistant foreman of the roundhouse at Knoxville, Tenn., has been appointed night foreman of the roundhouse; and Mr. J. A. Murrian has been appointed assistant foreman of the roundhouse at Knoxville.

Mr. Loyall A. Osborne, vice-president of the Westinghouse Electric & Manufacturing Company, and chairman of the executive committee of the National Conference Board, has been appointed by the Secretary of Labor, a member of committee on industrial peace during the war. The committee consists of five representatives of employers, five labor leaders, and two public men, and is expected to provide a definite programme in order that there may be industrial peace, thus preventing interruption of industrial production so as not to hamper the conduct of the war.

Mr. Albert J. Stone, vice-president of the Erie, has been appointed assistant to regional director Mr. A. H. Smith. Mr. Stone has earned a great reputation as a railroad operating expert. He has filled almost every position in the operating department of the Erie from that of yard clerk, and with the exception of two years' service as general superintendent of the Delaware & Hudson Company, his services have been with the Erie. He was for several years general manager and elected vice-president in July, 1914. Mr. Stone served as a member of the general operating committee of the Eastern

railroads which was formed last fall at Pittsburgh, in pursuance of a plan for unified railroad operation.

Mr. R. J. Himmelright has been elected vice-president of the America Arch Company. Mr. Himmelright is from Ohio, and graduated with the degree of mechanical engineer at Purdue University, and entered railroad service on the Lake

R. J. HIMMELRIGHT.

Shore and Michigan Southern as a special apprentice, and gained a wide experience in locomotive operation. After serving some time with the Locomotive Stoker Company as mechanical expert, in 1913 he accepted a position with the American Arch Company as traveling engineer, and latterly as manager of the service department which position he held at the time of his recent election.

Mr. William P. Kenney, who has been elected president of the Great Northern, entered railway service on the Chicago Great Western as a telegraph operator in 1888, and after serving in various clerical capacities in the company's service, he became contracting agent for the Empire Line in 1899, and in the same year went to the St. Paul & Duluth as chief clerk in the general freight office, and in 1900 was appointed chief clerk in the general freight office of the Northern Pacific. In 1902 he was chief clerk in the general freight office of the Great Northern, and was advanced to assistant general freight agent, assistant to the vice-president, assistant traffic manager, general traffic manager, and vice-president in charge of traffic.

The Chicago, Milwaukee & St. Paul announces the appointment of the following locomotive engineers to the position of traveling engineers: Mr. Ray Austin, Illinois division; Mr. W. H. Dempsey, Chicago & Milwaukee division; Mr. Henry Dersch, Prairie du Chien and Mineral Point divisions; Mr. Ralph E. Graves, Superior division; Mr. F. B. Higbee, Southern Minnesota division; Mr. B. A. Lembke, Wisconsin Valley division; Mr. George H. Lusk, Iowa West and Des Moines division; Mr. John P. Lutze, Iowa East and Middle division; Mr. A. M. Martinson, Racine & Southwestern, and Rochelle & Southern line; Mr. C. H. Crum, Kansas City division; Mr. George Parsage, Chicago Terminals, and Mr. H. S. Rowlands, Sioux City and Dakota division.

Mr. W. L. Reid has been elected vice-president and general manager of Lima Locomotive Works, Inc., with offices at Lima, Ohio. Mr. Reid was born at Paterson, New Jersey. His entire business life has been connected with locomotive building. He served his apprenticeship in the drawing office and shops of the Rogers Locomotive and Machine Works at Paterson and became successively erecting shop foreman, assistant superintendent and superintendent of the same plant. Leaving the Rogers works he was appointed assistant superintendent of the Brooks Locomotive Works and two years later superintendent of the Brooks Works. After serving only twenty days in the latter position he was appointed superintendent of the Schenectady Works of the American Locomotive Company. He was later appointed manager of the Schenectady plant, and general works manager of the American Locomotive Company, where his inventive ability introduced many important improvements. Resigning from the American Locomotive Company he became

W. L. REID.

general manager of the National Brake and Electric Co., Milwaukee, Wis. Six months later he resigned to become general superintendent of the Baldwin Locomotive Works at Eddystone, which position he held up to the time of his recent election.

OBITUARY

John Farquharson McIntosh.

Among the celebrated railroad officials who have recently passed away was John F. M'Intosh, locomotive superintendent of the Caledonian Railway. Born in Scotland, he entered the mechanical department of the Scottish North Eastern Rail-

JOHN FARQUHARSON M'INTOSH.

way at Montrose and lived in the same house with Angus Sinclair, and together they took up the study of mechanical subjects that helped them both in their careers. In running a locomotive Mr. M'Intosh had the misfortune to lose his right hand in an accident. He had already attracted attention as an earnest and studious engineer, and on his recovery was appointed locomotive inspector of the northern section of the road. His promotion was rapid. In 1876 he was appointed locomotive superintendent at Aberdeen. In 1884 he was placed in charge of the Caledonian's largest works, and in 1891 he became chief inspector of the locomotive department of the system with headquarters at Glasgow. In 1895 he was advanced to the chief position as locomotive, carriage and wagon superintendent, and retired in 1914, after 52 years service in railroad work. In 1897 he was awarded the gold medal at the Brussels Exhibition, and at the request of the Belgian government furnished designs for the locomotives of the state railways. He introduced oil fuel and superheaters in nearly all of the leading railroads in Great Britain as well as on some of the European continental and other foreign railways. In 1911 he was President of the Railway Locomotive Engineers, and in the same year King George created him a member of the Royal Victorian Order. Two of his sons are officers in active service in the British Army.

Railroad Equipment Notes

The Chicago, Burlington & Quincy has ordered 4 100-ft. and 1 90-ft. through turntables, totaling 365 tons.

The Guantanamo & Western has ordered 25 40-ton steel frame box cars from the American Car & Foundry Company

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The Midland Valley has purchased the old fair grounds at Wichita, Kan., and will build a new roundhouse, shops and switching yards.

The Grand Trunk Pacific will build a brick railway station, machine shops and roundhouse near Cameron Cove, Prince Rupert, B. C., to cost $250,000.

The Western Maryland has let a contract to the Price Concrete Construction Company, Maryland Trust building, Baltimore, Md., for a wheel shop at Hagerstown, Md.

The Missouri Pacific has ordered from the Union Switch & Signal Company an interlocking machine, 20 levers, to be installed in the place of an old machine at Halsey, Ill.

The Yazoo & Mississippi Valley has ordered from the Union Switch & Signal Company material for a mechanical interlocking plant, at Baton Rouge, La., 21 working levers.

The Canadian Pacific has ordered from the Union Switch & Signal Company material for mechanical interlocking, 13 working levers, at Komoka, Ont., to replace an old machine.

The St. Louis-San Francisco has ordered from the General Railway Signal Company a mechanical interlocking outfit, 35 working levers, to be installed by the railroad forces at Durant, Okla.

It is reported that only about 80 miles of steel remain to be laid on the Hudson Bay Railway, and part of this year's Canadian grain crop may be sent to Europe over this new short route.

The Canadian Government Railways have placed orders with the Canadian Locomotive Company for 6 six-wheel locomotives and 4 ten-wheel narrow-gage locomotives, to be delivered in June.

The United States Government has ordered 500 low-side gondola cars from the Haskell & Barker Car Company, and 375 high-side gondolas and 200 box cars from the Standard Steel Car Company.

The Canadian Government has placed an order for 100,000 tons of steel rails with the Dominion Iron & Steel Company. The government will afterwards sell the rails to different Canadian railways.

The Pittsburgh, Cincinnati, Chicago & St. Louis contemplates the construction of a roundhouse, machine shop and passenger station at Jeffersonville, Ind. The estimated cost of the latter structure is $20,000.

The Pennsylvania has let a contract to D. W. McGrath, Columbus, Ohio, for the construction of two buildings for its proposed locomotive repair shop at Columbus. A contract for three additional buildings will be let at an early date.

The United States Government has ordered for use on military railroads in France in addition to the 3,500 recently reported, 500 low side gondola cars from the Haskell & Barker Car Company and 375 high side gondolas and 200 box cars from the Standard Steel Car Company.

The Canadian Government railways reported taking 20,000 tons of 67-lb. rails, originally ordered by the Russian Government from mills in the United States. It is at present impossible to deliver the rails to Russia. A total of over 50,000 tons of Russian rails may be turned over to Canada the same report says.

Two important new subways in New York City, under Lexington avenue northward from the Grand Central Terminal, and in Seventh avenue, past the Pennsylvania station, now substantially completed, are likely to lie unused until about July 1, because of difficulty in getting materials for the electrical equipment of the power houses.

The Pennsylvania has ordered from the Union Switch & Signal Company material for a mechanical interlocing plant at Portage, Pa., 24 levers; an electro-pneumatic interlocking plant with 11 levers, at Paoli, Pa.; two electro-mechanical machines at the same place, and for extensive additions at Metuchen, N. J.; Harrisburg, Pa., and Denholm, Pa.

The Railway Department of Canada, of which Hon. J. D. Reid is Minister, is mapping out a big programme to meet the railway equipment requirements of the Dominion. The department estimates that there are needed at least 150 engines and 7,500 box cars. Inquiries are being made as to prices, specifications and number of engines and cars. A recommendation to the Cabinet Council will likely be made at an early date.

Books, Bulletins, Catalogues, Etc.

Powdered Coal as a Fuel.

An important book on the subject of "Powdered Coal as a Fuel," by C. E. Herington, M. E., and published by the D. Van Nostrand Company, New York, comes at a timely occasion, when the matter is being seriously considered not only by railroad men, but by all interested in the economical use of coal. The work extends to 211 pages, with 84 illustrations. The presswork and binding are excellent. The book is divided into 10 chapters, and treats fully of experiments with various grades of coal, various types of crushers, dryers, pulverizers, furnaces and burners. The use of powdered coal under boilers is also thoroughly described and fully illustrated. The early use, operation and tests of powdered coal for locomotives are particularly interesting, and the arguments in its favor by the use of the appliances now perfected are of the most convincing kind. It may not be generally known that the present annual consumption of powdered coal in the United States is over 8,000,000 tons, and its effectiveness and economy has been clearly demonstrated. Its use on the steam locomotive produces a saving of from 15 to 25 per cent. in coal of equivalent heat value, as compared with hand firing of coarse coal on grates. Powdered coal may run as high as 10 per cent. of sulphur and 35 per cent. in ash and still produce maximum steam-heating capacity; so that otherwise unsuitable and unsalable or refuse grades of coal may be utilized, and even the saving in cost per unit of heat evolved will be a considerable item.

Indeed it may be truly said that the latest efforts toward the burning of powdered coal in steam locomotives has now passed the experimental stage and arrangements have been completed for proceeding with commercial applications as rapidly as the equipment can be produced. Not only so, but the use of powdered coal permits the removal of the existing diaphragm, table and deflector plates, nettings, hand holes and and cinder hoppers, and makes possible the enlargement of the exhaust nozzle opening, and also dispenses with the use of the existing grates, ash pans, fire doors and operating gear. Three hand levers are all that is necessary to completely control the appliance in the regulation of the fuel and air supply to suit standing, drifting or working conditions.

We have before now described the appliance for burning powdered coal in locomotives in recent issues of Railway and Locomotive Engineering, but it may be briefly stated that the prepared fuel, having been supplied to an enclosed fuel tank, gravitates to the conveyor screws, which carry it to the fuel and pressure air feeders, where it is thoroughly commingled with and carried by the pressure air through the connecting hose to the fuel and pressure air nozzles and blown into the fuel and air mixers. In combustible form the fuel is drawn into the furnace by the action of the smokebox draft. In the matter of slag, ash and soot collected after each trip there is less than two handfuls.

The author also clears up the matter of explosions very thoroughly, showing that whatever few explosions have occurred in the past were entirely due to defective mechanism or carelssness, and that with the appliances now in use explosions are impossible. The author has had extensive experience and his statements have the verity of personal observation under all sorts and conditions of service. A finely collated bibliography completes the book. Price three dollars a copy.

Railroad Repair Shops.

From the report just issued by the Department of Commerce, embracing a census of manufactures, under the heading of railroad repair shops, it is stated that some idea of the magnitude of work required to keep the rolling stock in proper working condition can be gained by consulting the tables of statistics indicating that the enumerated reports show that there were 64,760 locomotives, 53,466 passenger service cars, 2,325,647 freight-service cars, and 124,709 company-service cars in use. The number of repair shops is given as 1,362, and employees as 361,925. The tables furnished show a decrease of over 10 per cent. in the early years of the century, due no doubt to the concentration of repair work in large repair shops.

Of the employees 99.7 per cent. were males and three-tenths of 1 per cent. females. Future reports will show a considerable increase in the latter class. The degree of fluctuation in the employment of wage earners in this industry was very small, the tendency showing a slight increase during the winter months. Sixty-six per cent. of the wage earners employed in the industry were in establishments where the prevailing hours of labor were 54 or fewer per week. A tendency toward a shorter working day is shown by the fact that the number employed in establishments operating less than 54 hours per week represented 36.8 per cent. as against 51 per cent. ten years ago. The tables also show that fewer locomotives and cars were built in steam railroad shops in 1914 than during some of the earlier census years, but at the same time the value of the work showed a considerable increase, owing doubtless to the increased weight of the motive power and rolling stock.

In regard to electric railroad repair shops the latest official reports show that 28,215 persons were employed in the in-

dustry, the average of females being even less than those engaged in steam railroad shops. In contradistinction in the matter of the fluctuation in the number of employees a slight increase is reported during the summer months. The number of establishments reported for the industry is 649, of which 34 per cent. employed over 500 persons in each establishment.

The Locomotive Furnace.

Bulletin No. 1, issued by the American Arch Company, consists of 16 pages and 12 illustrations, with an illuminated cover design, the text being the work of Mr. J. T. Anthony, assistant to the president, and intended as the first of a series of bulletins giving a general outline of the problems met with in firebox and boiler design—combustion, or the generation of heat; the transfer of heat by radiation, convection and conduction; heat absorption, evaporation and kindred subjects. There is a mastery of detail in the work, particularly in regard to the heat losses and such steps as have already been taken to overcome them. The author shows a thorough familiarity with the marked improvements that have been made in recent years, and points out clearly and forcibly that it is the furnace that controls the efficiency and capacity of the locomotive as a whole. It will be generally admitted that there has not been as much attention given to improvements in this important feature of locomotive construction as there might have been, but a degree of enlightened progress has already been reached that is altogether admirable, particularly in the thorough discovery of the variety of causes from which heat losses arise. The publication is not only timely in its appearance when the importance of fuel economy is so pressing, but it gives promise of still higher accomplishments in the realm to which it is devoted. Copies of the Bulletin may be had on application to the company's main office, 30 Church St., New York.

A Pennsylvania Poster.

Another large illuminated poster has just been distributed along the Pennsylvania lines, recapitulating the earnest and eloquent appeal made by the Director General of Railroads of the unselfish support of the government by every railroad officer and employee. The letterpress is of such size that he who runs may read. Briefly it is a call for co-operation among railway employees, not antagonism; confidence, not suspicion; mutual helpfulness, not grudging performance; just consideration, not arbitrary disregard of each other's rights and feelings; a fine discipline based on mutual respect and sympathy; and an earnest desire to serve the great public faithfully and efficiently. The document fittingly closes with an assurance by President Samuel Rea that the officers and employees will continue to acquit themselves honorably and faithfully, and with ever-renewed devotion to the great national service in which they are engaged, they will be found equal to the great emergency.

Combustion of Coal and Design of Furnaces.

Bulletin 135, issued from the government printing office, is of unusual interest, containing as it does the details of elaborate tests of coal combustion, and designs of furnaces with description of apparatus and practical application of results. The size of combustion space required for any desired completeness of combustion, rate of firing, and the effect of the excess air on combustion are shown by a series of diagrams. The possibility of the combustion of bituminous coal without smoke or soot is clearly demonstrated. It is shown that soot is formed at the surface of the fuel bed by heating the hydrocarbons in absence of air. It is not formed by the hydrocarbon gases striking the cooling surfaces of the boiler. As a matter of fact only a very small trace of the hydrocarbon gases ever reach the surface of the boiler. Hydrocarbons that do so are prevented from decomposition by the cooling effect of the contact. The cooling surfaces do not cause the formation of soot; they merely collect soot and prevent its combustion. It seems that most mechanical stokers are smokeless not because they burn the smoke, but because they burn the coal in such a way that very little soot or smoke is produced. Hand-fired furnaces are smoky because soot is produced in or near the fuel bed, and can not be burned in the limited combustion space of the furnace. Copies of this publication may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D. C.

MacRae's Blue Book.

Mr. Albert MacRae, the accomplished editor of the *Santa Fe Magazine*, has shown his patriotic desire to aid the Government in the purchase of railway material. The annual periodical known as MacRae's Blue Book, furnishes a classified index of over 12,000 articles used on railways, and also shows in alphabetical order the names and addresses of all important manufacturers, with trade names, together with a list price section, and a miscellaneous data section. The book extends to fifteen hundred pages, and is usually sold at ten dollars per copy. Mr. MacRae offered the book free to the various Governmental departments, some of whom had been already using the book, among others the chief of engineers having ordered seventy-four copies. Mr. MacRae's offer has been gratefully accepted by the Government, and 210 copies have been already furnished, and letters of thanks and appreciation have been received by Mr. MacRae from hundreds of the leading army officers. The 1918 edition is the best hitherto published, and in its particular field stands alone.

Motor-Driven Compressors.

The Westinghouse Traction Brake Company, Industrial Department, under date of February, 1918, has issued a high grade finely illustrated, copyrighted booklet, 6 x 9 inches, 113 pages, describing in detail its complete line of motor driven compressors, both stationary and portable installations, ranging in capacities from 11 to 110 cubic feet. Compressed air accessories, for doing almost every possible kind of work, are included. All users of compressed air tools will find many new features and valuable labor saving help in this book, designated as Publication No. 9035.

Railway Statistics.

The Bureau of Railway News and Statistics has issued their fourteenth annual volume from the press of Rogers & Hall Company, Chicago, Ill. It is full of valuable data, finely condensed and arranged. The work is of real value as furnishing reliable facts to railway men.

Petroleum Industry.

A bulletin on the petroleum industry recently completed shows that in the nine months ended September 30 stocks of oil decreased 9,779,000 barrels.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXI 114 Liberty Street, New York, May, 1918 No. 5

Specifications of the United States Government Standard for Locomotives

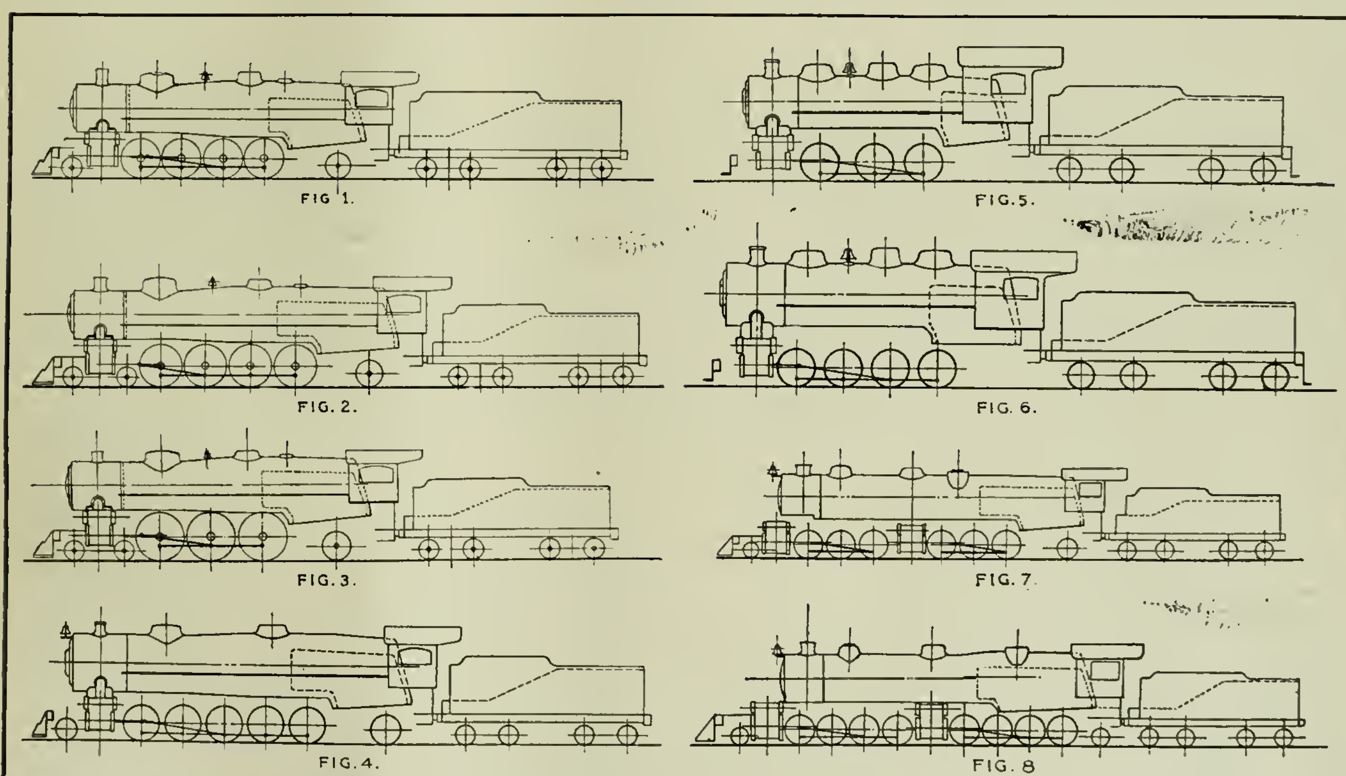


FIG. 1. PROPOSED U. S. GOVERNMENT STANDARD LIGHT AND HEAVY MIKADO TYPE 2-8-2 ENGINE. Fig. 2. LIGHT AND HEAVY MOUNTAIN TYPE 4-8-2. FIG. 3. LIGHT AND HEAVY PACIFIC TYPE 4-6-2. FIG. 4. LIGHT AND HEAVY 2-10-2 TYPE. FIG. 5. SIX WHEEL SWITCHER. FIG. 6. EIGHT WHEEL SWITCHER FIG. 7. MALLET LOCOMOTIVE 2-6-6-2. FIG. 8. MALLET LOCOMOTIVE 2-8-8-2.

It is with great satisfaction that the evident aim in framing the Government standard equipment designs and specifications there appears to be a desire to admit a broad scope of interchangeable appliances. We are glad to record the assurance by the Director-General that his purpose is to encourage (during Government control) the demonstration and adoption of improvements which are yet to be established. This is a policy of progress, and will tend to preserve and stimulate the industrial enterprises whose purpose it is to achieve mechanical advance in the science of transportation. We earnestly commend to the Director-General's consideration the fact that a large proportion of these enterprises rest upon patent rights and that an indispensable essential to preserving the enterprises themselves is to maintain unimpaired the normal status of patents. The owner of a patent who makes a contract with a manufacturer has an agreement which cannot be abrogated without his consent and which he may not be in position to abrogate. The royalties are the earnings of his patent. The enterprise which owns patents has for an asset, (in some cases—its chief asset as a going business) the right of protection against under-bidding by concerns whose overhead cost has not included the experimentation, demonstration, development, or the improvement of the device. The Director-General has evidently no desire to disturb or disrupt business, and many of the fears that have been hastily expressed, may be found, on careful examination, to be entirely groundless.

The specifications for standard locomotives for the United States Government, which we give, are made up of a list of dimensions one each for several kinds of motive power. These include a light and a heavy Mikado type of

locomotive, 2-8-2. Beginning with the lighter type we have:—General Dimensions, Light Mikado, 2-8-2 engines. Fig 1. Gauge, 4 ft. 8½ ins.; Fuel, soft coal; Cylinders, Simple; Diameter, 26 ins.; Stroke, 30 ins.; Drivers, Diameter, 63 ins.; Working Pressure, 200 lbs.; Boiler, Diameter, 78 ins.; Type, conical wagon Top; Fire Box, 114⅛ ins. long; 84¼ ins. wide; Tubes, No. 216, Diameter, 2¼ ins.; Flues, No. 40, Diameter, 5½ ins.; Length, 19 ft. 0 ins.; Heating Surface (approximate) Firebox & Combustion Chamber, 259 sq. ft.; Fire brick tubes, 27 sq. ft.; 2¼ in. tubes, 2407 sq. ft.; 5½ in. Flues, 1090 sq. ft.; Total, 3,783 sq. ft.; Grate area, 67.7 sq. ft.; Ratio to heat. surf., 1 to 56.8; Superheating surface, 882 sq. ft.; Wheel base, driving, 16 ft. 9 ins.; Wheel base, Total Engine, 36 ft. 1 in.; Wheel base, Engine & Tender, 71 ft. 5½ ins.; Weight in working order (approximate) on drivers, 220,000 lbs.; on Front truck, 23,000 lbs.; on Back Truck, 47,000 lbs.; Total engine, 290,000 lbs.; Tender, 172,000 lbs.; Tractive Power, 54,600 lbs.; Ratio of Adhesion, 4.02; Water Capacity, 10,000 gals.; Fuel capacity, 16 tons. Limiting conditions. Loaded drawing dimensions: 15 ft. 0 ins. high; 10 ft. 4 ins. width over cylinders; 10 ft. 0 ins. over cab body; 10 ft. 2 ins. over cab eaves and boards, not including cab handles. Curves, 19 degs.; Grades, 2 per cent.; Turntables, 85 ft.

General Dimensions, Heavy Mikado 2-8-2 engine. Fig. 1. Gauge, 4 ft. 8½ ins.; Fuel, soft coal; Cylinders, simple Diameter, 27 ins.; Stroke, 32 ins.; Drivers, Diameter, 63 ins.; Working pressure, 190 lbs.; Boiler, diameter, 86 ins.; Type, Conical wagon top; Firebox, 120⅛ ins. long; 84¼ ins. wide; Tubes, No. 247, diameter, 2¼ ins.; Flues, No. 45, diameter, 5½ ins.; Length, 19 ft. 0 ins.; Heating Surface (approximate) Fire Box & Combustion Chamber, 292 sq. ft.; Fire Brick Tubes, 27 sq. ft.; 2¼ in. Tubes, 2752 sq. ft.; 5½ in.; Flues, 1226 sq. ft.; Total, 4297 sq. ft.; Grate area, 70.8 sq. ft.; Ratio to heat. surf., 1 to 60.5; Superheating surface, 993 sq. ft.; Wheel Base, driving, 16 ft. 9 ins.; Wheel base, Total Engine, 36 ft. 1 in.; Wheel base, Engine & Tender, 71 ft. 9½ ins.; Weight in Working Order (Approximate) on drivers, 240,000 lbs.; on Front Truck, 27,000 lbs.; on Back Truck, 58,000 lbs. Total engine, 325,000 lbs.; Tender, 172,000 lbs.; Tractive power, 60,000 lbs.; Ratio of Adhesion, 4; Water capacity, 10,000 gals.; Fuel capacity, 16 tons. Limiting conditions. Loaded drawing dimensions: 15 ft. 0 ins. high; 10 ft. 4 ins. width over cylinders; 10 ft. 0 ins. over cab body; 10 ft. 2 ins. over cab eaves and boards, not including cab handles. Curves, 19 degs.; Grades, 2 per cent; Turntables, 85 ft.

General Dimensions, Light Mountain or 4-8-2 engine: Fig. 2. Gauge, 4 ft. 8½ ins.; Fuel, soft coal; Cylinders, Simple; Diameter, 27 ins.; Stroke, 30 ins.; Drivers, Diameter, 69 ins.; Working Pressure, 200 lbs.; Boiler, Diameter, 78 ins.; Type, Conical wagon top Fire Box, 120⅛ ins. long; 84¼ ins. wide; Tubes, No. 216, diameter, 2¼ ins.; Flues, No. 40, diameter, 5½ ins.; Length, 20 ft. 6 ins.; Heating Surface (approximate) Fire Box and Combustion Chamber, 329 sq. ft.; Fire brick tubes, 27 sq. ft.; 2¼-in. tubes, 2598 sq. ft.; 5½-in.-Flues, 1176 sq. ft.; Total, 4130 sq. ft.; Grate area, 70.8 sq. ft.; Ratio to heat. surf., 1 to 58.2; Superheating surface, 957 sq. ft.; Wheel Base, driving, 18 ft. 3 ins.; Wheel base, total engine, 40 ft. 0 ins.; Wheel base, Engine & Tender, 75 ft. 8½ ins.; Weight in Working Order (Approximate) on drivers, 220,000 lbs.; on Front Truck, 50,000 lbs.; on Back Truck, 50,000 lbs.; Total Engine, 320,000 lbs.; Tender, 172,000 lbs.; Tractive Power, 53,900 lbs.; Ratio of Adhesion, 4.08; Water capacity, 10,000 gals.; Fuel capacity, 16 tons. Limiting conditions. Loaded drawing dimensions: 15 ft. 0 ins. high; 10 ft. 4 ins. width over cylinders; 10 ft. 0 ins. over cab body; 10 ft. 2 ins. over cab eaves and boards, not including cab handles. Curves, 19 degs.; Grades, 2 per cent; Turntables, 85 ft.

General Dimensions, Heavy Mountain on 4-8-2 engine: Fig. 2. Gauge, 4 ft. 8½ ins.; Fuel, soft coal; Cylinders, Simple; Diameter, 28 ins.; Stroke, 30 ins.; Drivers, Diameter, 69 ins.; Working Pressure, 200 lbs.; Boiler, diameter, 86 ins.; Type, Conical Wagon Top; Fire Box, 114⅛ ins. long; 96¼ ins. wide; Tubes, No. 247, diameter, 2¼ ins.; Flues, No. 45, diameter, 5½ ins.; Length, 20 ft. 6 ins. Heating surface (approximate) Fire box and Combustion chamber, 346 sq. ft.; Fire brick tubes, 27 sq. ft.; 2¼ in. tubes, 2970 sq. ft.; 5½ in. Flues, 1323 sq. ft.; Total, 4666 sq. ft.; Grate area, 76.3 sq. ft.; ratio to heat. surf., 1 to 61.1; Superheating surface, 1078 sq. ft.; Wheel base, driving, 18 ft. 3 ins.; Wheel base, Total Engine, 40 ft. 0 ins.; Wheel Base, Engine & Tender, 75 ft. 8½ ins.; Weight in Working order (approximate) on drivers, 240,000 lbs; on Front Truck, 55,000 lbs.; on Back Truck, 55,000 lbs.; Total Engine, 350,000 lbs.; Tender, 172,000 lbs.; Tractive power, 58,000 lbs.; Ratio of Adhesion, 4.13; Water Capacity, 10,000 gals.; Fuel capacity, 16 tons. Limiting conditions. Loaded drawing dimensions: 15 ft. 0 ins. high; 10 ft. 4 ins. width over cylinders; 10 ft. 0 ins. over cab body; 10 ft. 2 ins. over cab eaves and boards, not including cab handles. Curves, 19 degs.; Grades, 2 per cent; Turntables, 85 ft.

General Dimensions, Light Pacific or 4-6-2, Fig. 3, passenger engine: Gauge, 4 ft. 8½ ins.; Fuel, soft coal; Cylinders, Simple; Diameter, 25 ins.; Stroke, 28 ins.; Drivers, Diameters, 73 ins.; Working Pressure, 200 lbs.; Boiler, Diameter, 76 ins.; Type, Conical Wagon Top; Fire Box, 114⅛ ins. long; 84¼ ins. wide; Tubes, No. 188, diameter, 2¼ ins.; Flues, No. 36, diameter, 5½ ins.; Length, 19 ft. 0 ins.; Heating Surface (approximate) Fire box and Combustion Chamber, 234 sq. ft.; Fire brick tubes, 27 sq. ft.; 2¼-in. tubes, 2091 sq. ft.; 5½ in.-Flues, 981 sq. ft.; Total, 3333 sq. ft.; Grate area, 66.7 sq. ft.; Ratio to heat. surf., 1 to 50; Superheating surface, 794 sq. ft. Wheel base, driving, 13 ft. 0 ins.; Wheel base, Total Engine, 34 ft. 9 ins.; Wheel base, Engine & Tender, 68 ft. 7½ ins. Weight in working order (Approximate) on drivers, 165,000 lbs.; on Front Truck, 52,000 lbs.; on Back Truck, 53,000 lbs.; Total Engine, 270,000 lbs.; Tender, 144,000 lbs.; Tractive Power, 40,700 lbs.; Ratio of Adhesion, 4.05; Water capacity, 8,000 gals.; Fuel capacity, 16 tons. Limiting conditions. Loaded drawing dimensions: 15 ft. 0 ins. high; 10 ft. 4 ins. width over cylinders; 10 ft. 0 ins. over cab body; 10 ft. 2 ins. over cab eaves and boards, not including cab handles. Curves, 19 degs.; Grades, 2 per cent; Turntables, 85 ft.

General Dimensions—Heavy Pacific or 4-6-2, Fig. 3, passenger engine: Gauge, 4 ft. 8½ ins.; fuel, soft coal; cylinders, simple; diameter, 27 ins.; stroke, 28 ins.; drivers, diameter, 79 ins.; working pressure, 200 lbs.; boiler, diameter, 78 ins.; type, conical wagon top; firebox, 120⅛ ins. long, 84¼ ins. wide; tubes, No. 216, diameter, 2¼ ins.; flues, No. 40, diameter, 5½ ins.; length, 19 ft. 0 ins.; heating surface (approximate): firebox and combustion chamber, 284 sq. ft.; firebrick tubes, 27 sq. ft.; 2¼-in. tubes, 2,407 sq. ft.; 5½-in. flues, 1,090 sq. ft.; total, 3,808 sq. ft.; grate area, 70.8 sq. ft.; superheating surface, 882 sq. ft.; ratio to heating surface, 1 to 54; wheelbase, driving, 14 ft. 0 ins.; wheelbase, total engine, 36 ft. 2 ins.; wheelbase, engine and tender, 70 ft. 8½ ins.; weight in working order (approximate): on drivers, 180,000 lbs.; on front truck, 60,000 lbs.; on back truck, 60,000 lbs.; total engine, 300,000 lbs.; tender, 144,000 lbs.; tractive power, 43,800 lbs.; water capacity, 8,000 gals.; ratio of adhesion, 4.12; fuel capacity, 16 tons. Limiting conditions: Loaded drawing dimensions, 15 ft. 0 ins. high; 10 ft. 4 ins., width over cylinders; 10 ft. 0 ins. over cab body; 10 ft. 2 ins. over cab eaves and boards, not including cab handles; curves, 19 degs.; grades, 2 per cent.; turntables, 85 ft.

General Dimensions—Light 2-10-2 freight engine: Fig. 4. Gauge, 4 ft. 8½ ins.; fuel, soft coal; cylinders, simple; diameter, 27 ins.; stroke, 32 ins; drivers, diameter, 57 ins.; working pressure, 200 lbs.; boiler, diameter, 86 ins.; type, conical wagon top; firebox, 114⅛ ins. long, 96¼ ins. wide; tubes, No. 247, diameter, 2¼ ins.; flues, No. 45, diameter, 5½ ins.; length, 20 ft. 6 ins.; heating surface (ap-

proximate): firebox and combustion chamber, 346 sq. ft.; firebrick tubes, 27 sq. ft.; 2¼-in. tubes, 2,970 sq. ft.; 5½-in. flues, 1,323 sq. ft.; total, 4,666 sq. ft.; grate area, 76.3 sq. ft.; superheating surface, 1,078 sq. ft.; ratio to heating surface, 1 to 61.1; wheelbase, driving, 21 ft. 0 ins.; wheelbase, total engine, 40 ft. 4 ins.; wheelbase, engine and tender, 76 ft. 0½ ins.; weight in working order (approximate): on drivers, 275,000 lbs.; on front truck: 30,000 lbs.; on back truck, 55,000 lbs.; total engine, 360,000 lbs.; tender, 172,000 lbs.; tractive power, 69,400 lbs.; ratio of adhesion, 3.96; water capacity, 10,000 gals.; fuel capacity, 16 tons. Limiting conditions: Loaded drawing dimensions, 15 ft. 0 ins. high; 10 ft. 4 ins., width over cylinders; 10 ft. 0 ins. over cab body; 10 ft. 2 ins. over cab eaves and boards, not including cab handles; curves, 19 degs.; grades, 2 per cent.; turntables, 85 ft. This is a tentative specification.

General Dimensions—Heavy 2-10-2 freight engine: Fig. 4. Gauge, 4 ft. 8½ ins.; fuel, soft coal; cylinders, simple; diameter, 30 ins.; stroke, 32 ins.; drivers, diameter, 63 ins.; working pressure, 190 lbs.; boiler, diameter, 88 ins.; type, conical wagon top; firebox, 132⅛ ins. long, 96¼ ins. wide; tubes, No. 271, diameter, 2¼ ins.; flues, No. 50, diameter, 5½ ins.; length, 20 ft. 6 ins.; heating surface (approximate): firebox and combustion chamber, 399 sq. ft.; firebrick tubes, 30 sq. ft.; 2¼-in. tubes, 3,258 sq. ft.; 5½-in. flues, 1,469 sq. ft.; total, 5,156 sq. ft.; grate area, 88.2 sq. ft.; superheating surface, 1,230 sq. ft.; ratio to heating surface, 1 to 58.4; wheelbase, driving, 22 ft. 4 ins.; wheelbase, total engine, 42 ft. 2 ins.; wheelbase, engine and tender, 82 ft. 10½ ins.; weight in working order (approximate): on drivers, 300,000 lbs.; on front truck, 30,000 lbs.; on back truck, 60,000 lbs.; total engine, 390,000 lbs.; tender, 206,000 lbs.; tractive power, 74,000 lbs.; ratio of adhesion, 4.05; water capacity, 12,000 gals.; fuel capacity, 16 tons. Limiting conditions: Loaded drawing dimensions, 15 ft. 9 ins. high; 10 ft. 9 ins., width over cylinders; 10 ft. 0 ins. over cab body; 10 ft. 2 ins. over cab eaves and boards, not including cab handles; curves, 19 degs.; grades, 2 per cent.; turntables, 85 ft. This is a tentative specification.

General Dimensions of a Six-wheel Switcher (Fig. 5)—Gauge, 4 ft. 8½ ins.; fuel, soft coal; cylinders, simple; diameter, 21 ins.; stroke, 28 ins.; drivers, diameter, 51 ins.; working pressure, 190 lbs.; boiler, diameter, 66 ins.; type, straight top; firebox, 72⅛ ins. long, 66¼ ins. wide; tubes, No. 158, diameter, 2 ins.; flues, No. 24, diameter, 5½ ins.; length, 15 ft. 0 ins.; heating surface (approximate): firebox, 130 sq. ft.; firebrick tubes, 16 sq. ft.; 2-in. tubes, 1,233 sq. ft.; 5½-in. flues, 515 sq. ft.; total, 1,894 sq. ft.; grate area, 33 sq. ft.; superheating surface, 475 sq. ft.; ratio to heating surface, 1 to 57; wheelbase, driving, 11 ft. 0 ins.; wheelbase, total engine, 11 ft. 0 ins.; wheelbase, engine and tender, 48 ft. 10½ ins.; weight in working order (approximate): on drivers, 165,000 lbs.; total weight of engine, 165,00 lbs.; tender, 144,000 lbs.; tractive power, 39,100 lbs.; ratio of adhesion, 4.22; water capacity, 8,000 gals.; fuel capacity, 16 tons. Limiting conditions: Loaded drawing dimensions, 15 ft. 0 ins. high; 10 ft. 4 ins., width over cylinders; 10 ft. 0 ins. over cab body; 10 ft. 2 ins. over cab eaves and boards, not including cab handles; curves, 19 degs.; grades, 2 per cent.; turntables, 85 ft. This is a tentative specification.

General Dimensions of an Eight-wheel Switcher. (Fig. 6.) Gauge, 4 ft. 8½ ins.; fuel, soft coal; cylinders, simple; diameter, 25 ins.; stroke, 28 ins.; drivers, diameter, 51 ins.; working pressure, 175 lbs.; boiler, diameter, 80 ins.; type, straight top; firebox, 102⅛ ins. long; 66¼ ins. wide; tubes, No. 230, diameter, 2 ins.; flues, No. 36, diameter, 5½ ins.; length, 15 ft. 0 ins.; heating surface (approximate): firebox, 190 sq. ft.; firebrick tubes, 22 sq. ft.; 2-in. tubes, 1,796 sq. ft.; 5½-in. flues, 773 sq. ft.; total, 2,781 sq. ft.; grate area, 46.6 sq. ft.; superheating surface, 637 sq. ft.; ratio to heating surface, 1 to 59; wheelbase, driving, 15 ft. 0 ins.; wheelbase, total engine, 15 ft. 0 ins.; wheelbase, engine and tender, 52 ft. 10½ ins.; weight in working order (approximate): on drivers, 220,000 lbs.; total weight of engine, 220,000 lbs.; tender, 144,000 lbs.; tractive power, 51,200 lbs.; ratio of adhesion, 4.3; water capacity, 8,000 gals.; fuel capacity, 16 tons. Limiting conditions: Loaded drawing dimensions, 15 ft. 0 ins. high; 10 ft. 4 ins., width over cylinders; 10 ft. 0 ins. over cab body; 10 ft. 2 ins. over cab eaves and boards, not including cab handles; curves, 19 degs.; grades, 2 per cent.; turntables, 85 ft. This is a tentative specification.

General dimensions of a 2-6-6-2 Mallet Engine. (Fig. 7.) Gauge, 4 ft. 8½ ins.; fuel, soft coal; cylinders, compound, diameter, h. p., 23 ins.; l p., 35 ins.; stroke, 32 ins.; drivers, diameter, 57 ins.; working pressure, 225 lbs.; boiler, diameter, 90 ins.; type, straight top; firebox, 114⅛ ins. long; 96¼ ins. wide; tubes, No. 247, diameter, 2¼ ins.; flues, No. 45, diameter, 5½ ins.; length, 24 ft. 0 ins.; heating surface (approximate): firebox and combustion chamber, 402 sq. ft.; firebrick tubes, 27 sq. ft.; 2¼-in. tubes, 3,478 sq. ft.; 5½-in. flues, 1,549; total, 5,456 sq. ft.; grate area, 76.3 sq. ft.; superheating surface, 1,260 sq. ft.; ratio to heating surface, 1 to 71.6; wheelbase, driving, 31 ft. 2 ins.; wheelbase, rigid, 10 ft. 4 ins.; wheelbase, total engine, 50 ft. 2 ins.; wheelbase, engine and tender, 88 ft. 10 ins.; weight in working order (approximate): on drivers, 360,000 lbs.; on front truck, 27,000 lbs.; on back truck, 53,000 lbs.; total engine, 440,000 lbs.; tender, 206,000 lbs.; tractive power, 80,300 lbs.; ratio of adhesion, 4.48; water capacity, 12,000 gals.; fuel capacity, 16 tons. Limiting conditions: Loaded drawing dimensions, 15 ft. 0 ins. high; 10 ft. 6 ins., width over cylinders; 10 ft. 0 ins. over cab body; 10 ft. 2 ins. over cab eaves and boards, not including cab handles; curves, 19 degs.; grades, 2 per cent. This is a tentative specification.

General Dimensions of a 2-8-8-2 Mallet Engine. (Fig. 8.) Gauge, 4 ft. 8½ ins.; fuel, soft coal; cylinders, compound; diameter, h. p., 25 ins.; l p., 39 ins.; stroke, 32 ins.; drivers, diameter, 57 ins.; working pressure, 240 lbs.; boiler, diameter, 98 ins.; type, conical wagon top; firebox, 176⅛ ins. long, 96¼ ins. wide; tubes, No. 274, diameter, 2¼ ins.; flues, No. 53, diameter, 5½ ins.; length, 24 ft. 0 ins.; heating surface (approximate); firebox and combustion chamber, 400 sq. ft.; firebrick tubes, 32 sq. ft.; 2¼-in. tubes, 3,960 sq. ft.; 5½-in. flues, 1,825 sq. ft.; total, 6,217 sq. ft.; grate, 144 ins. long, 96¼ ins. wide; grate area, 96.2 sq. ft.; superheating surface, 1,475 sq. ft.; ratio to heating surface, 1 to 65.2; wheelbase, driving, 42 ft. 1 in.; wheelbase, rigid, 15 ft. 6 ins.; wheelbase, total engine, 57 ft. 4 ins.; wheelbase, engine and tender, 93 ft. 3 ins.; weight in working order (approximate): on drivers, 480,000 lbs.; on front truck, 30,000 lbs.; on back truck, 30,000 lbs.; total engine, 540,000 lbs.; tender, 206,000 lbs.; tractive power, 106,000 lbs.; ratio of adhesion, 4.52; water capacity, 12,000 gals.; fuel capacity, 16 tons. Limiting conditions: Loaded drawing dimensions, 15 ft. 9 ins. high; 10 ft. 9 ins., width over cylinders; 10 ft. 0 ins. over cab body; 10 ft. 2 ins. over cab eaves and boards, not including cab handles; curves, 19 degs.; grades, 2 per cent. This is a tentative specification.

United States Government Orders for Rolling Stock.

It has been decided that the Federal government will have the priority in the matter of having orders filled for railway equipment necessary for the increased requirements of transportation. Assurances have been received from the manufacturers that the steel required for the 2,000 locomotives to be ordered, and also for the 100,000 cars is available, but in the latter case the quantity of steel plates used will be reduced It is expected that the order for cars will be duplicated before the end of the year and probably 1,000 locomotives. About 40,000 tons of rails are now being delivered weekly.

Cutting Rust From Bolt Threads.

Mix some powdered emery with grease and smear the threaded parts both on the bolt and the inside of the nut, then turn the nut on the bolt and run it back and forth over the threads. This method will be found effective even in the most stubborn cases. Many schemes have been tried, before now, to remove rust, but this is as expeditious as any we know of.

Powerful Santa Fe or 2-10-2 Type Locomotive For the Belt Railway of Chicago

The Baldwin Locomotive Works has recently completed five locomotives of the Santa Fe or 2-10-2 type, for the Belt Railway of Chicago. These are heavy engines, specially designed and equipped for hump-yard service. At the same time the wheel arrangement is suitable for transfer or road service should it be necessary to use the locomotives in such work. These engines exert a starting or tractive force of 84,400 lbs. and are built to the largest dimensions permitted by the specified weight and clearance limits. The sharpest curves on which they operate are of 10 degs. radius.

The boiler has a straight top, with a deep firebox placed back of the drivers and over the trailing truck. The firebox contains an arch, and has a combustion chamber 28 ins. long; while the tubes are 23 ft. long. The boiler barrel is composed of three rings, and the third ring is sloped on the bottom in order to provide a sufficiently deep water-space under the combustion chamber. In consideration of the nature of the service, which will require the development of full power for short periods of time only, a stoker has not been applied: but the firedoor is power-operated. Details of the boiler construction include flexible stay bolts in the breaking zones, three rows of Baldwin expansion stays over the front end of the combustion chamber crown, and an auxiliary dome for the safety-valves, which is placed over a 16-in. diameter opening in the boiler shell. The circumferential seam at the junction of the boiler barrel and outside firebox is triple riveted, and the shell diameter at this point is 100 ins. A transverse baffle plate is placed immediately ahead of the combustion chamber.

The superheater has 50 units, which are in five horizontal rows of the boiler flues with ten flues in each row. This is a large superheater, providing, as it does, 1,418 sq. ft. of surface, which is equivalent to 27 per cent. of the water evaporating surface.

The steam distribution is controlled by 16-in. piston valves; and the valve gear is of the Baker type, controlled by the Ragonnet power reverse mechanism. The combining-lever link of the valve motion, is attached directly to an extension of the cross-head pin. The pistons have steel centers, with gun iron bull rings and packing rings; and the piston rods and cross-head keys are of vanadium steel.

The frames are of .40 per cent. carbon steel and of heavy construction, as they have a width of 6 ins. and a depth over the driving pedestals of 7 ins.; while the single front rail, to which the cylinders are bolted has a depth of 13 ins. The pedestal binders are attached by three bolts in each end. The boiler barrel is supported on the frames at four points, viz.: by vertical plates bolted to the guide yoke and valve motion bearer, and to crossties placed respectively between the third and fourth, and fourth and fifth pairs of drivers. The main drivers have plain tires, and the main driving boxes are of the Cole pattern. A trailing truck of the Hodges type is used in this design, and it is equalized with the three rear pairs of drivers through a transverse beam which is suspended from the back driving springs. The truck is fitted with a centering spring.

This locomotive is equipped for switching service, and has a step on the front bumper instead of a pilot. Four sand boxes are provided, and are placed right and left on the round of the boiler. To keep within the clearance limits, the bell is also placed on the round of the boiler on the left-hand side, and the whistle is similarly located and is tapped directly into the roof sheet.

The tender carries 10,000 gallons of water and 16 tons of fuel. It has a frame built of 12-in. channels with cast steel bumpers; and the connection between the engine and tender is provided with a radial buffer. This is an interesting case of the adaptation of a road type of locomotive to special yard service. The leading dimensions of these engines are given in the table which follows:

Cylinders, 30 x 32 ins.; valves, piston, 16 ins. diam. Boiler—Type, straight; diameter, 90 ins.; thickness of sheets, 7/8 and 15-16 ins.; working pressure, 200 lbs.; fuel, soft coal; staying, radial. Fire box—Material, steel; length, 132 1/8 ins.; width, 96 ins.; depth, front, 89 ins.; back, 75 7/8 ins.; thickness of sheets, sides, 3/8 ins.; back, 3/8 ins.; crown, 3/8 ins.; tube, 5/8 ins. Water space—Front, 6 ins.; sides, 6 to 4 ins.; back, 4 ins. Tubes—diameter, 5½ ins. and 2¼ ins.; material, steel; thickness, 5½ ins., No. 9 W. G.; 2¼ ins., No. 11 W. G.; number, 5½ ins., 50; 2¼ ins., 238; length, 23 ft. 0 ins. Heating Surface—Fire box, 263 sq. ft.; combustion chamber, 64 sq. ft.; tubes, 4,863 sq. ft.; firebrick tubes, 39 sq. ft.; total, 5,229 sq. ft.; superheater, 1,418 sq. ft.; grate area, 88 sq. ft. Driving wheels—diameter, 58 ins.; journals, main, 13 ins. x 22 ins.; other journals, 11 ins. x 13 ins. Eng. truck wheels—diameter, front, 33 ins.; journals, 6 ins. x 10 ins.; diameter, back, 44 ins.; journals, 8 ins. x 14 ins. Wheel base—driving, 21 ft. 0 ins.; rigid, 21 ft. 0 ins.; total engine, 40 ft. 3 ins.; total engine and tender, 76 ft. 7½ ins. Weight—On driving wheels, 336,000 lbs.; on truck, front, 23,000 lbs.; on truck, back, 46,000 lbs.; total engine, 405,000 lbs.; total engine and tender, about 592,000 lbs. Tender—wheels, number, 8; diameter, 33 ins.; journals, 6 x 11 ins.; tank capacity, 10,000 U. S. gals.; fuel capacity, 16 tons; service, hump switching.

This engine is intended to move heavy, long strings of cars up the ascending grade of the hump and be able to hold them there; stop and start the whole train quickly as one, or two cars are tipped over the hump.

HEAVY 2-10-2 FOR THE BELT RAILWAY OF CHICAGO.

E. F. Jones, Mast. Mech. Baldwin Loco. Wks., Builders.

The Director General on Standards.

In reply to the open letter of Mr. Geo. A. Post, president of the Railway Business Association, addressed to Hon. William G. McAdoo, concerning the standardization of locomotives and locomotive material, Mr. Post says he submitted two questions:

"*First*—Are the recently constituted committees on Locomotives and Cars expected to recommend to the Director General standards to be adhered to, not only in the building of the new locomotives and cars, now under consideration for the immediate relief of traffic, but as well to all power and vehicles that may be required during the period that the railways shall remain under the administration of the Director General? Also, are such standards, when approved by the Director General, to apply and govern in the matter of repairs to equipment during such period?

"*Second*—During the period that the railways are under the control of the Director General, will it be considered so important to adhere rigidly to any standard that may be now approved, as to cause a cessation of trial, development and acceptance of any new mechanical inventions intended to improve and economize railway operation?"

With these two questions propounded for his consideration, Mr. McAdoo proceeded to express his ideas responsive thereto. Mr. Post says he does not attempt to record fully his exact language, but to condense, animated by an eager desire to report faithfully and fairly the viewpoint of the Director General: Mr. McAdoo said, in effect:

As Director General of Railroads, it is his duty to see that our railroads are put in condition to perform with the highest degree of efficiency possible the vital part they must play in winning the war. That their performance thus far has not met the requirements is a fact known to everybody. They must have, as quickly as possible, among other things, large additions to their power and rolling stock. The purchase of such equipment will call for the expenditure of vast sums. The natural thought of an official responsible for such expenditure, and for the least possible delay in delivery of sadly needed locomotives and cars is: "To what extent may they be standardized?" As a matter of general knowledge, Mr. McAdoo was aware that the American Railway Association, made up of the railway executives of the country, had for several years had committees at work for the accomplishment of standardization, so that it was clear the subject was a live one with railway administrators long before the roads were taken over by the government under stress of war. The roads had not agreed when the change of control occurred.

When Mr. McAdoo assumed the directorship, the roads were taken over as going concerns, and their official personnel was not disturbed, except as he has called upon some of the gentlemen of distinction in their service to become members of his official staff. When he sought to be advised as to how far standardization of equipment might be effected, he caused to be appointed committees made up of locomotive and car builders and railway mechanical officials, representative of the regional districts which had been created. Mr. McAdoo disclaims being a railroad man, and is utilizing the forces he finds at hand to suggest what ought to and may be done in the solution of this particular railway problem. He has laid down no rules for their conferences, has no preconceived notions, and has given his advisers free rein. No reports or recommendations from them have yet been received by him (March 6).

Whether he will approve of all their recommendations when received, he does not know, of course, but this he would like the manufacturers of railway material, as represented by the Railway Business Association, to appreciate, namely—that any embarrassments, losses, or necessary expenditures for the purpose of adaptation to the new standards will be entailed not by his personal initiative or prescription, but as the consensus of opinion of those with whom they have heretofore done business and to meet the exigent requirements of war conditions. If the railroad executives had formulated standards before the war, manufacturers would have been obliged to endure and adapt themselves to the changes ordained by their customers.

Of course, he went on, there can be no such thing as a permanent standard for railway practice. America and progress are synonomous terms. The old gives place to the new in the onward march of progress. There was never a time when the inventive genius of our nation so needed to be working at highest speed as now. No matter what may be established as a standard for new equipment under the present pressure for celerity of manufacture and attainment of economy he would hope and expect that when future requirements shall confront us, the inventor and progressive manufacturer will offer improvements of great value, to be welcomed as aids to economical and efficient railway operation. During the period that the roads shall remain under governmental control, it will be the determination of the officials in charge that our railroads shall be made better than ever before. Anybody who has plans to suggest for improvement will be hospitably received.

The proposed standards are for the immediate present, and for new equipment to be purchased. They will not apply to existing equipment, which must be kept in repair with parts already intended for such repairs. It would be folly to prescribe that cars requiring repairs must await the arrival of new standard parts, instead of being repaired with specialties already in stock, or easily obtained from the manufacturers.

Accepting the figures presented by the Railway Business Association, for the purpose of his comment, there are now in use and under maintenance 63,862 locomotives and 2,326,987 cars. No one would consider it wise to do anything save keeping them in service as long as they can be made to last by the use in their repair of such devices as were originally used in their construction. In so doing there would be a continuing demand for such stocks of supplies as the manufacturers keep on hand to meet requirements.

Mr. McAdoo can see no reason for the manufacturers of railway material and equipment to be filled with fear for their future. They should, on the contrary, take counsel of their hopes. He expects to see them doing a greater volume of business than in recent years and at a fair profit. There will be no trouble for any manufacturer who is willing to do business at a fair price.

Peat Fuel

To determine the steam-raising value of peat fuel with hand-firing a series of six tests were recently carried out in Canada, using peat with a moisture content of 15 and 20 per cent. and a calorific value between 7,000 and 7,500 B. T. U. Results showed that the equivalent evaporation per pound of coal of about 12,500 B. T. U. was about 8, while with peat the evaporation was about 4 per cent. The thermal efficiency with the coal was of the order of 60 per cent. and, with the peat, 53 per cent. The low figure in the latter case is due to incomplete combustion of the gases and to their high temperature when leaving the boiler. In trials with a locomotive type of boiler a conspicuous feature was the great losses due to unburnt gases, which varied from 11 to 24 per cent.

American Locomotives in China

An American firm has just completed delivery of two Mikado type locomotives for the Pekin-Mukden railway in China for freight service. Their total weight including tender is 134 tons. As is well known this type of engine was first brought out to fulfill a requirement in Japan, and became known as the Mikado. Three of this type of locomotive had been previously in service, and an order for fourteen more has just been made. They are said to be giving great satisfaction, and it is likely that further orders will be received.

At the Works of the Nathan Manufacturing Company

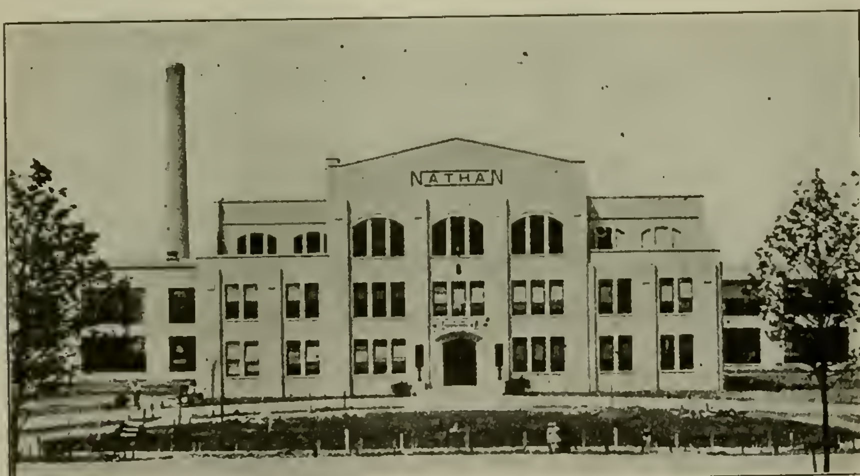
Flushing, Long Island, New York

The new works of the Nathan Manufacturing Company, located at Flushing, a suburb of New York, are now in full operation, and in so far as producing the finished boiler mountings of the modern locomotive is concerned, the works are not only the most complete, but the most extensive of their kind in the world. Forty years' experience has developed a mastery in detail, and an application of means and methods that can only come as the result of the most painstaking scientific inquiry conducted by leading mechanical engineers combining great natural aptitude with special training.

The older works, located at 106th street and East River, New York, may be said to be now entirely occupied in government munitions work, for which the fine plant is admirably adapted. The company has the advantage therefore of devoting the new establishment with its excellent accessories of transportation by land or water exclusively to its chosen field of locomotive and allied work, and the result, as we have stated, places it in a class by itself.

Glancing briefly at the architectural features of the buildings, which are of reinforced concrete throughout, the administration building occupies the frontal position, and its neat and artistic design is greatly enhanced by an extensive circular driveway which leads from the main gateway through and around an oval lawn flanked by terraces that are being transformed into sloping gardens, upon which the landscape artists are displaying their skill, and which will presently blossom in rainbow beauty as the summer advances. From each floor of the administration building is a passageway to balconies at the end of the craneway that runs the entire length of the structure beyond the administration building. From these balconies, observations may be taken of the factory operations. Provision is made in the craneway for two traveling cranes, each of seven-ton capacity, pipe trenches and three communicating bridges for use of the second floor. The entire craneway is covered with wire glass.

It will be noted from the general block plan of the buildings that beyond the administration building a plan is evolved which permits the reduction or addition of a number of pairs of wings, each wing being capable of being extended several bays in length. There are three of these pairs of units or wings, extending 150 ft. on each side of the craneway. Additions may be later built without interfering in any way with the original building, and without interrupting any of the operations of the plant. These wings are about 50 ft. in width, the courts between the wings varying from 30 ft to 40 ft. The light afforded by the courts give an out-of-door lightness to every part of the works, particularly on the second story, where the greater part of the lathes and other machines are located.



ADMINISTRATION AND WORK BUILDING FOR NATHAN MANUFACTURING COMPANY, FLUSHING, LONG ISLAND, NEW YORK. EUGENE SCHOEN, architect.

It would be tedious to describe in detail the series of operations through which the material passes from the raw state as it comes to the foundry, to the finished product as it arrives in the receptacles that line both sides of the craneway, where the various parts may be readily reached and conveyed speedily to the packing rooms. Suffice it to say that the operations and endless variety of tools are such that every conceivable detail seems to have been carefully considered in advance, so that no part of the product has at any time other than a forward movement in the process of manufacture, and does not have to pass through the same shop twice. The succession of operations follow each other in uninterrupted sequence, nearly all the machines apparently being automatic in action, and unerring in execution. In the machine shops the lathes are set back to back, like bricks in a wall, so that the operators are not brought face to face with each other, but like stars dwell apart, each in his own sphere of activity. The floor spaces between the rows of lathes are ample for the movement of motor-driven vehicles, and the movement of material is like an endless chain. As may be expected, the work is almost entirely specialized and the operators naturally become experts at their own specialties. There is no persistent clamor for efficiency, the mute, insensate machine provides the efficiency, and the operators have an air of satisfaction that bespeaks complete contentment with the prevailing piece work rates.

The assembling of the parts, which is performed by high-skilled mechanics, is paid on the time basis, although delays or defects are extremely rare, the operating proceeding with the regularity of an eight-day clock. Many of the machines are of the automatic multiple-spindle variety, and among others there is a new type of Bullard machine with twelve spindles acting horizontally, adapted for work on lubricators, the rough casting being clamped in place by the operator and by a slight turning of a lever the various operations are performed by the rapidly revolving tools that come successively into action, and in a few minutes the complete dozen have done their work, and the lubricator with all its threaded orifices and double seated recesses and bevelled valve seats and finished faces may be said to be ready for the assembling division. The burnishing brigade have a turn or two at it however, and it was interesting to note that even here there are also improvements in means and methods. A strong blast of air rushes along a pipe underneath the burnishing wheels, and a hood-like contrivance reaches partially over each wheel, and the dust from the cleaning and burnishing process rushes into the conduit beneath. Wandering molecules of matter that may happen along in the outer air are drawn into this vortex and never to return, and the operator remains unspotted.

The tool room is in itself an epitome of the ingenuity and self-reliance of the enterprising company. As may be readily imagined, many of the smaller and more complex tools are made by their own machinists, and the company has been peculiarly fortunate in securing and retaining the services of the most skilled

artisans in the tool making department, which is the crowning accomplishment of the master machinist. This happy faculty of retaining the services of the most skilled mechanics is marked by the presence of many men who have spent more than half a life time in the company's service, and consequently the loss of skilled workmen by the country's call to arms has fallen lightly on the company's employees for the reason that there were comparatively few young men in the service.

In this regard it was interesting to observe the very considerable number of young women now engaged in the works, and how cleverly they seem to be adapting themselves to their various occupations. In the core making department of the foundry their work was of surpassing excellence and rapidity. The blue-print makers had a commodious section to themselves, and if all blue-prints were at all comparable to their work, many weary eyes would be spared attempting to decipher the puzzling inscriptions.

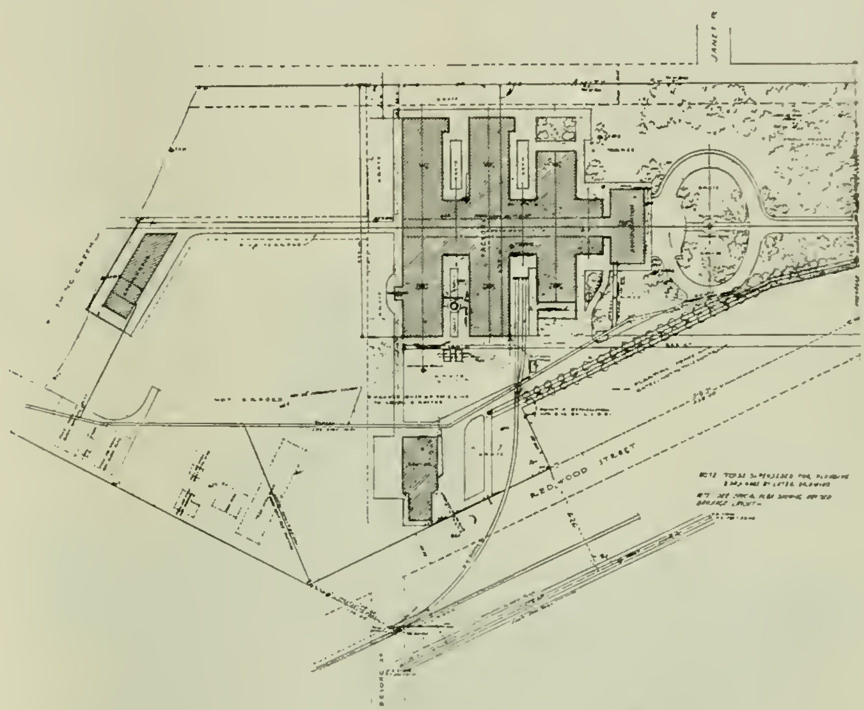
Details of the laboratories, testing rooms, annealing plants, nickel plating appliances, drawing rooms, and packing departments, each and all would take pages of description by themselves. Suffice it to say that all were provided with every facility calculated to produce the best results in the requirements of the service. The multitudinous accessories looking toward the comfort of the employees are a liberal example to all who have the welfare of workers at heart. Roof gardens, recreation rooms, dining rooms, hospital rooms and appliances and hospital nurses into whose hands one would wish to fall if he falls at all, not forgetting the accomplished chef from France, and his skilled assistants whose gastronomic ability persuaded us to linger longer in the dining room than is our wont.

Of the floors, it would be invidious to make comparisons, but we know by hard experience that a plain, concrete floor is hard on the feet even for workers who move about. Creosoted wood blocks laid in a thin layer of sand and pitched with asphalt is the prevailing kind of flooring in the Nathan Company's new shops. A paving block flooring is laid in the shipping room where the vehicular traffic is heavier, and it seems to us that this important feature has been well considered.

With regard to the transportation facilities, it will be noted on the general block plan that the works are located near an estuary of Long Island Sound, known as Flushing Creek. A new wharf is constructed there and a store house about three hundred feet west of the main factory buildings in connection with the new wharf. This building, 40 ft. by 150 ft., has also reinforced concrete walls with slab roof, supported on steel roof trusses and purlins, and it is in this vacant space between the store house and the factory buildings where extensions may be made as the natural expansion of the demand for the company's products may call in the undiscovered future. A spur from the adjacent Long Island Railroad also enters the works, and hence transportation both by land and water is immediately at hand.

Such is a brief outline of the salient features of the new plant and if we have omitted the commodious power house, where some of the boilers are of ⅞-in. steel and carry a pressure of 275 lbs. per square inch, it is because the works seemed to be full of power. Electric motors were thick as blackberries, hanging in clusters overhead, coupled to far-reaching shafting revolving at high velocities. The notable feature in such a colossal mechanical establishment was the almost complete absence of noise, this may be partly owing to the comparative lightness of the work, but is also easily distinguishable by the exquisite fineness of the bearings, the absence of loose pulleys, and other noise-provoking adjuncts of a bygone age. Nor should we overlook the garage just south of the main factory building, measuring 50 ft. by 120 ft. and constructed similar to the storehouse. A portion of the garage is two stories in height, and the upper floor arranged for apartments.

To conclude, it may be justly said that the feeling that arises on passing through and even casually observing the operators and the appliances is that of moving through an exposition rather than a factory. Everything seems at its best. There is a quiet precision and an air of refinement that is far removed from the general condition of factory workers. The usual sets of rules and regulations, which nobody reads, are conspicuous by their absence. There are no fiery placards signed by threatening fire commissioners or other self-advertising authorities. It is all utility brought nearly to perfection. This is not accidental, but the concrete essence of a rare spirit of ingenuity polished by experience and sweetened by kindness, and in the directors' room there is a painting of the founder of the company. It hangs alone, and like King Arthur of old, it does not take much imagination to believe that like his knights of the round table, the people that live and move and have their being in connection with the establishment are like the fabled knights—all stamped with the image of the master—Max Nathan.



GENERAL BLOCK PLAN. NATHAN MANUFACTURING BUILDING.

The Calorific Value of Wood

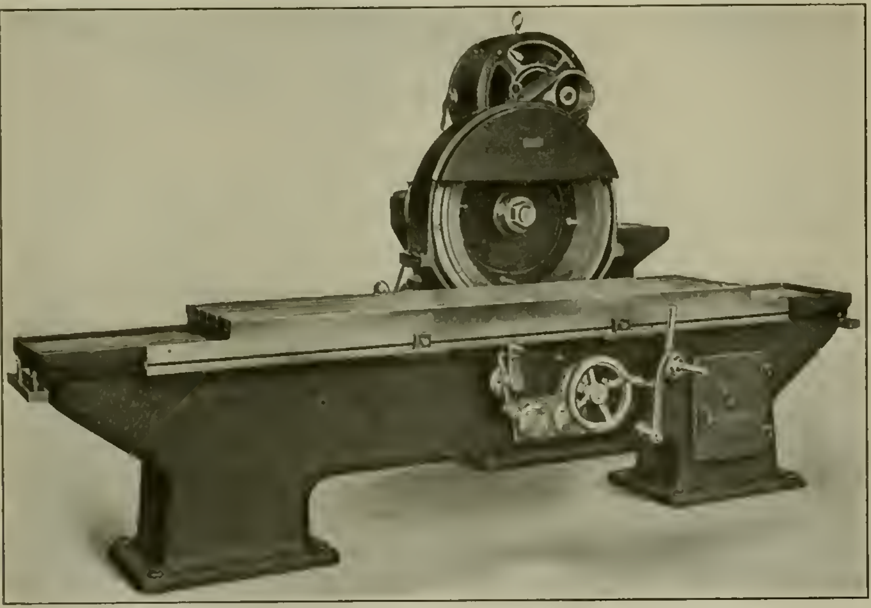
The calorific value of wood varies directly as its weight; thus a cord of white oak weighs approximately 4,000 lbs. and is equivalent to one ton of anthracite coal, and a cord of spruce or pine weighs in the neighborhood of 2,000 lbs., and is equivalent to one-half ton of coal. The principal hardwoods available for fuel are maple and birch, which weigh between 3,000 and 3,500 lbs. to the cord. Dry wood is very much better and more efficient than green wood, which contains at least 25 per cent. moisture. This water requires heat in order to be evaporated, and this passes up the flues. In these days of fuel economy it is well to know the calorific value of wood, and its comparison with coal as in many districts wood is coming into use as fuel.

New Design of Shop Face Grinder

Installed in the Works of the Hay-Budden Manufacturing Company

We had the opportunity of witnessing the installment of the latest development in grinding machinery in the extensive works of the Hay-Budden Manufacturing Company, Brooklyn, N. Y., the well-known firm, whose specialty is solid-forged anvils, in the manufacture of which the company produced the first made in America. Since the beginning of the war the demand for the company's products has increased amazingly, not only in their specialty as anvil makers, but in varieties of heavy and light forgings. It became necessary to look for improved machinery, and among other details the grinding of anvil faces occupied considerable time and skill under the old methods. The machine shown in our illustration was originally designed for grinding hardened locomotive guide bars, but this is now only one of its many uses, and may be readily applied to almost every variety of forging or casting that may require a finished straight surface on any part desired. The machine produces smooth flat finished surfaces with great rapidity. For general shop work in removing stock up to ⅛ in. in thickness, and where surfaces to be ground are not of extensive width, it is in many cases much more rapid and satisfactory than a planer, shaper or milling machine. The machine has already been found very serviceable on a wide range of work, such as large iron and steel floor plates, flanged water pipes, metor cases, column bases, lathe legs and the like.

An excellent feature of the machine consists in its being operated either from the front or rear, the operator having the machine entirely under his control from either position. This is often of importance when grinding complex shapes. Varying degrees of hardness of the articles being ground does not affect the perfect evenness of the finished work . The movements of the mechanism being much more rapid than is the case on a planer or milling machine, there is no time lost in reversing the wheel grinding on both the forward and backward movement of the table. The grinding wheel is held in an adjustable chuck. This is a measure of safety because it has been frequently demonstrated that all wheels of this kind revolving at high velocities should not run unsupported.



SHOP FACE GRINDER, MOTOR DRIVEN, STYLE "D."

The wheel is 30 ins. in diameter and runs about 550 revolutions per minute. Any kind of abrasive wheel that is best suited for the work, either emery, carborundum or corundum, may be supplied with the machine. The wheel holder occupying only a limited space enables the wheel to be used down to a very economical point before it is necessary to replace it with a new wheel. At the same time all chances for accidents arising from wheel bursting are completely prevented. The bearings are massive and have bronze boxes adjustable for wear and thoroughly protected from dust. The end thrust when in operation is taken by a ball thrust-bearing insuring complete absence of oscillation. The table as well as the cross feed is either automatic or operated by hand.

The general nature of the work performed in this way requires that the machine should be of the most substantial kind, consequently these machines are unusually heavy, and are built either for motor drive, as shown in our illustration, or belt driven. A 15-horse power motor is used on the motor-driven machines, and the motor is placed directly on the back of the head of the machine. No countershaft, either upon the floor or ceiling, is necessary. The weight of the motor-driven machine, including the motor, is about 12,000 lbs., the weight of the belt-driven machine being about 11,000 lbs..

The following are some of the general dimensions of the machine: Length of bed, 11 ft. 2 ins.; size of table, 7 ft. 2 ins. by 1 ft. 7½ ins.; table travel per minute, 15 ft.; wheel spindle bearing, rear, 3¼ ins. by 10 ins.; front, 3½ ins. by 12 ins.

How to Make a Cold Chisel.

When the chisel has been forged to the required shape the end should be finished by grinding or filing, and it should then be hardened and tempered. This should be done in one heat. The edge of the chisel should be tempered to a deep plum color, verging on blue. The difficulty is that although the extreme edge may be of the correct tint, yet if the color is allowed to run down too fast the metal behind the edge will be too soft, will set under the shocks of the hammer and break. Then, again, if the color is allowed to run down too slowly, the metal behind the edge will be too hard, and pieces will break off bodily. The best way is to heat the chisel a very dull red for a good inch up from the edge, holding the tongs in the left hand and in the right a rub stone (a piece of broken grindstone or emery wheel, or, failing these, a strip of emery cloth wrapped round a small file). Dip the chisel for about half an inch until it just turns black, then withdrawing it from the water and letting it rest against the side of the pail, so as to steady it, rub it sharply with the stone, or emery to brighten it, and watch the color as it runs down from the part which is still hot, and when the edge is of a deep plum color, verging on blue, quench it right out.

Care of Belts

If a pulley has a burnished, glassy surface it means that the belt has been slipping. The discrepancy in the speed due to a creeping belt may not be evident, but it is there and it means a constant waste of both power and material. The reason for this may be that the pulley is too small for the work, that the belt is slack or too frail, or that a bad type of belt fastener is used.

The Packing of Truck Journal Boxes

An interesting discussion in relation to the report of a committee submitting recommendations for changes in the Master Car Builders' rules, occurred recently at a meeting of the Car Foremen's Association of Chicago. The recommendation set forth that a rule be put into effect providing for the regular repacking of journal boxes at stated intervals, and also a proper method of stenciling on the car the date of repacking, and further that the car owner be made responsible for the labor only of repacking journal boxes, the material cost to be borne by the handling line for the reason that it would be difficult to establish a value on reclaimed waste which is now used very extensively by a great many roads, and for the further reason, where the reclamation of waste is carried out along proper lines, there is very little expense involved in the repacking of journal boxes, other than labor.

It might be stated briefly that the matter has already received a good deal of consideration at the hands of various committees of the Master Car Builders' Association, but no exact standardization of rules in regard to the matter has so far been established. The first rule referring to the care of foreign cars specifies that "each railway company must give to foreign cars, while on its line, the same care as to inspection, oiling, packing, adjusting brakes and repairs, that it gives to its own cars."

It was stated in the discussion that only a few railroads and private car lines have adopted this method of repacking and inspection, but it has been found to be a profitable undertaking from the first, and there is no reason why the railroads who have carried this art beyond the experimental stage should not put all cars on their rails in as good condition as possible at the owner's expense and insure a quick movement of cars, not only as a patriotic duty, but as a war measure for the safe and prompt delivery of commodities. Coincidentally it is a well known fact that cut journals are due to the neglect in properly taking care of journal boxes and contained parts. The number of cars cut out by all the railroads in the United States on account of hot boxes is approximately 93,000 cars per month, and much saving could be effected if each one of our many railroads would adopt a system of periodical repacking and attention to journal boxes which is necessary to prevent the expense.

The repacking of boxes at specified periods is also a subject of vital interest, and is capable of amendment. It was shown that journal boxes that may have been packed in Chicago may pass through a flooded district before they reach New Orleans, and consequently some foreign matter will in all likelihood have reached the packing. The packer is not likely to be over zealous in inspecting these boxes, especially as the stencil will show that the box was packed a day or two ago. A proper inspection at each terminal might take more time, but it would be the means of saving more than it cost.

Regarding the reclaiming of waste, or second hand packing, some roads are now reclaiming as much as 90 per cent. of the packing removed, and find that it is in every way as good as new packing. At the same time it was almost the unanimous opinion of those who took part in the discussion that the method of repacking the boxes and the material used should be standardized before the rule enforcing it, and making it chargeable to the owner is put into effect. Meanwhile some roads are using the very best quality of wool packing obtainable while others are using mixtures of inferior quality frequently a poor grade of cotton waste, and some of it of a vegetable fiber having little or no capillarity whatever, so that a system of standardization is necessary to protect those who are using good material against others who are using inferior stuff.

The general opinion seemed to be that the association should go on record as demanding the best and recommending that, so that all may be given a chance to use it. Those who are already using a good quality of packing would then get the benefit and would not have a miscellaneous and inferior quality of packing put into their boxes. As it is, it may be said that all roads use their own packing and many are controlled by the purchasing department, which, in order to stand in with the higher officials, frequently purchase a so-called woolen waste at a very low price and will present this to the management, claiming that it is just as good, and it saves so much by using this material, while at the same time it is hardly worth the time and labor, as its use cannot do other than lead to premature trouble, whereas on the other hand the best material has the quality when reclaimed and resaturated of being better than new waste, it being frequently demonstrated under the microscope that the oil cleansed the fibre and the oil appeared in a greater quantity on the reclaimed waste than it did the first time.

It was also claimed during the discussion that there is no road purposely neglecting the inspection of cars, because it involves the safety of transportation over its own rails, and the majority of the speakers emphasized the fact that their roads were following a regular system of repacking journal boxes and getting good results, and as a matter of fact, the majority of the roads in the country, the principal trunk lines particularly, are following good practice. The idea, however, was approved of, that better results would be obtained if the Master Car Builders' Association should lay down specific rules in regard to the matter that would be universally adhered to, and every road throughout the country would use the same standard of waste, and all who endeavored to maintain the essence of perfection in the packing of car journal boxes would find that when cars go to another line that they will still get the same treatment in material as on their own line. In this connection it may be added that the association has already recommended a specification for a standard waste, but it seems to have been looked upon as not sufficiently mandatory in its application.

Some of the outcroppings of the discussion were of much value. As an instance, it was stated that in the reclaiming of waste, the packing should not be immediately dumped into the vat on being removed from the journal boxes. The packing should be first placed on a sorting table and the short parts removed. This also removes the bits of babbitt or other foreign matter, and only the good packing is put into the reclaiming vat and carried out, the scrap material being burned to reclaim the babbitt and this reclaimed babbitt is taken into consideration when giving credit to the owner for packing removed from his car.

The general conclusion arrived at was that after the Master Car Builders' Association had time and opportunity to give the matter full consideration and establish a standard packing, a rule should be put into effect penalizing those who may be found guilty of an infraction of the standard regulations. The discussion was particularly interesting in view of the evident earnestness and frankness of all who participated in the debate. As might be expected, there was a natural tendency to lay blame on the other roads rather than to expose the shortcomings that may exist on the road in which the speaker was employed. There were no indications of attempting to exalt some particular brand of material, the chief note being a strong desire to reach a standardization not only in materials but in methods, and that the final rules and regulations in regard to the packing and inspection of car truck journal boxes should be established and promulgated by the association having the authority to do so. That this will eventually be done is a foregone conclusion, but in the strenuous days when so much is looked for, railway men, like all other men, must continue to exercise a patience that never wearies, and they must always and ever hope and work for the best.

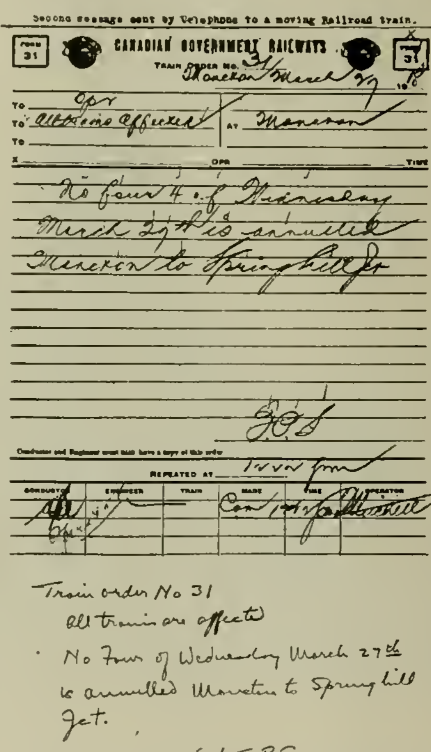
Telephone Reaches a Moving Train

A short time ago the Canadian Government conducted a test of a new invention whereby telephonic communication can be readily and surely established between the train dispatcher's office and a train actually moving along the track, miles away from headquarters. The conductor of the moving train on hearing the dispatcher's voice and noting what he says, can then telephone the engineman on the swaying and rushing machine; he is heard quite distinctly by the engineman, with the surge and roar of the engine is endered quite inaudible through the telephone, which simply reproduces the sounds from the caboose. Further than this, an ordinary city telephone operator can give you the dispatcher who reaches the conductor on the moving train, and the conductor connects you with your old friend, Mr. A. O. Brookside, first-class passenger traveling west at the time, and you can say to him, "Hello! 'Brooky,' old man, are you walking or flying or riding, and how are you?" And you can hear Mr. Brookside laugh and reply as plainly as if he and you were face to face.

One thinks of telephoning to a person on a rapidly-moving train as if it was almost uncanny. So it is, as far as human experience goes, but in the world of applied science there is no wonder, everything acts in accordance with law. This speaking is not a transmission of voice. It is a transmission of minute fluctuations in a current of electricity caused by the vibrations of the small telephone diaphragm found in both receiver and sender of an ordinary telephone outfit. How the sound impulses striking the diaphragm cause it to vibrate, as a whole, and at the same time forces the surface to divide itself into numerous nodes and vibrating segments so that the very overtones of the speaker's voice are reproduced, we need not now stop to consider. The transmission through the telephone, over the wire, along the track and through the receiver is electrical, and at the almost infinite pace at which electricity travels, all things to it are stationary. Imagine a train bowling briskly along at 30 miles an hour, under the power of steam and steel, and suddenly overtaken by a force whose prodigious velocity is 186,000 miles a second. Electricity, if it were sentient, would not know that the train was in motion just as a bullet with 3,000 ft. muzzle velocity would treat a man slowly walking as if he was stationary.

But to return from the contemplation of this fascinating glimpse into the fairyland of science, let us say that the practical demonstration given by the MacFarlane Train Control and Telephone Company, of New York, with their apparatus was made on the Canadian Government Railways at Moncton, N. B., Can., on March 27, 1918. The test was conducted between Moncton and Humphrey's station. Mr. L. S. Brown, general superintendent of the Canadian Government Railways; Mr. W. R. Devenish, superintendent; Mr. R. G. Gage, signal and electrical engineer of the Canadian Government Railways, and other officials were present at the testing of the invention, as well as the inventor, Mr. W. W. MacFarlane, and his partner, Mr. D. W. Mulford, of New York; Mr. C. W. Parker, electrical engineer of the C. P. R., and Mr. Thomas Roger, representing the superintendents of railway telegraph and telephone service of the United States of America, were also present.

During the test, which was very complete, the conversations were carried on between the moving train and the dispatcher's office in a clear and distinct manner.



TRAIN ORDERS TELEPHONED. MESSAGES "SENT" AND "RECEIVED" ON MOVING TRAIN.

The engine was cut off from the car and proceeded a mile down the track by orders telephoned from the conductor to the engineer. The engine was then stopped by telephone orders from the conductor, who was on the car, and instructed to come back and couple up again. Then an order was given by the conductor to back up the train and take on the flagman, who had gone back to flag.

Before backing up, a telephone message was sent to the dispatcher's office, asking if it was safe to back up, and the answer by telephone from the dispatcher was that this would be all right. After backing up to the flagman, the order was receiveo from the dispatcher's office to go ahead to Humphrey's and cross over to the other track and come back to Moncton. Before reaching Humphrey's a second telephone message was received from the dispatcher countermanding the previous order to cross over, but to return to Moncton on the same track, as the train was protected from the rear.

All these instructions were transmitted by telephone from the dispatcher's office to the conductor on the car and by him transmitted to the engineer by telephone, while the car was running, showing that it is perfectly feasible to control a moving train by telephone from the dispatcher's office at a distant point.

Communication was also established between the moving train and the city telephone service. The Canadian Government Railway officials expressed themselves as thoroughly satisfied with the practicability of the whole test, the equipment used and the highly important work which was then, and can always be done by this means, of reaching a train which is usually, under such circumstances, completely out of the range of control and entirely beyond help.

Not only is the startling statement made but it has been verified that communication is possible to establish between a moving train and the city telephone service, which makes it possible for one to talk directly through the telephone in one's hotel room to someone on a train 100 miles away running sixty miles an hour.

The material used in installing the "railway telephone" is not costly, being standard goods found in any well-equipped electrical supply house throughout the country and it is most easily applicable.

Telephone wires are attached to the front and rear trucks of any form of cars now in use on the various railroads. The wires are attached to the engine and to the tender. The voice transmission takes place through the wheels and down to the rails, where it runs along and is picked up by the engineer, conductor, or dispatcher, whichever party the signal indicates the message is for.

Just here a most interesting and exceedingly useful feature of the whole scheme of telephoning to a train by means of track circuit and wheels, axles and train wires, should be mentioned. It is this: The block signal system divides the track into sections, and each section can be reached separately. In this country an accident might destroy a section or a "block," but the block on each side of the mutilated one could be reached by telephone, and a train in front or behind the wreck could be spoken to as if nothing

had happened. This feature, excellent as it is for us, might be of priceless value in France, where the United States Government have miles of railway behind the Allied line.

Here, mistake, inadvertence, or accident may destroy a sectional block of track, and we would find the telephone with this feature of the highest utility. Not so. in degrees of convenience only, in France. There the enemy of Liberty, free thought, and strong development, constantly endeavors to break the continuity of the line. If evil fortune permits him, with some high explosive, to destroy a "block" of track, he but hampers a bit of the line, because the telephone can reach trains on either side of the damaged portion. Thus are those who have enslaved science and made her work for ignoble ends, and prostituted the knowledge God has given us as a reward for hard labor and conscientious thought—these men are beaten at their own game by applied science, and it is from this country that the new thought and impulse comes.

It is not for us to prescribe a course

TELEPHONE CONNECTION BETWEEN ENGINE AND TENDER.

of action to the Government or to say that this or that remedy is infallible. We offer this suggestion, however, that the Government look into this whole matter of telephone connection to a moving train and the adjunct that goes with it, of reaching trains separated by an impassable area, or trains in distress, or those that as they proceed may pick up information priceless to the army.

If not used here at present, the telephone will some day be so used, but its utility for military lines looks to us to be of the highest value today, when freedom stands with its back against the wall fighting for the right.

The State of the Case.

The Railway Business Association has recently issued a bulletin for the use of its members, dealing with the railway situation as it is now. The whole document, which is too extensive for reproduction here, is nevertheless full of information, useful to the railway man, the supply man, and to others. We therefore desire to quote one or two of the most pertinent paragraphs.

First in importance, it seems to us, comes the railway control act, and the suspension of rate advances by the Interstate Commerce Commission when initiated by the administrator of railroad operation. This is abolished for the period to be covered. Under government control the operating administrator is technically the President and actually the Director General. "The President" is empowered to initiate rates and practices, which upon complaint the Interstate Commerce Commission may review and amend or set aside; but pending final adjudication the President's order shall not be suspended. This relieves government operation of the provision of law under which company operation has had to work, authorizing suspension of rates when filed by carriers pending final determination. The Railway Business Association opposed the original enactment of suspension power on the grounds (1) that a railway manager filing a rate advance should be presumed innocent of unreasonableness or discrimination until proved guilty; (2) that if the advance went into effect when filed and was disallowed the carrier could refund, but that if it were suspended and ultimately sanctioned, the carrier could not collect the revenue which it had lost in the meantime; and (3) that in practice suspensions would clog the docket and the consequent delays would deprive rate structures of quick adaptability to changing commercial conditions. From within the commission has come the criticism that the suspension power was being used too freely.

Adequacy of revenue as a consideration in the making of rates is for the first time adopted in this measure as a policy of the federal government. The provision is that when the commission is considering appeals from the President's orders affecting rates, and the President certifies reasons for increase of operating revenues, including among such reasons operating expenses, taxes, net rentals for joint facilities and equipment and compensation to the carriers, "the Interstate Commerce Commission in determining the justness and reasonableness . . . shall take into consideration said finding and certificate by the President together with such recommendations as he may make." The elements which in this provision Congress says the commission "shall" take into consideration are the elements which the Railway Business Association has urged Congress to specify in defining the aim of regulation. "Compensation to the carriers" under government operation would read, as applying to non-government operation, "surplus as a basis for credit." There have always been members of the commission who specified among their reasons for voting against rate advances the conviction that the law as it stands does not make it a part of the duty of the commission or clothe the commission with power to consider adequacy of earnings and maintenance of credit in regulating rates.

Financing of new facilities is provided for by an appropriation of $500,000,000 as a revolving fund to pay expenses of federal control, to defray deficits where carriers' net income falls short of the government guarantee and "to provide terminals, motive power, cars and other necesary equipment." The President may order carriers to make improvements, including not only rolling stock and betterments to road but "road extensions," and advance them sums from the revolving fund.

Termination of government operation is explicitly provided for in the section which prescribes continuance of government control not exceeding 21 months beyond the President's peace proclamation. The original "Administration" text as drawn by Interstate Commerce Commissioner Anderson would have made the period of government control indefinite. The General Executive Committee of the Railway Business Association in its report of March 14, "Plan for Important Change of Scope," advocates "the preservation of individual initiative in the investment of capital and in management," "reliance upon the judgment of the investing public in projecting enterprises of construction or improvement," "responsibility of the owners or their representatives for selection of operating executives," "maintenance in railroading of a career outside the government," "preservation of government regulation."

Teak the Hardest Timber.

People familiar with different kinds of wood are aware that African teak is the hardest timber known to the mechanical industries. So indestructible is African teak wood that vessels built of it have lasted over one hundred years. The peculiarity of this wood is its hardness and great weight, causing extraordinary durability. Its weight varies from 42 to 52 pounds per cubic foot. It works easily considering its hardnesss, but the large quantity of silex in the substance require the tools to be extremely hard and even then they are subject to rapid wear. It also contains an oil which prevents nails driven into it from rusting.

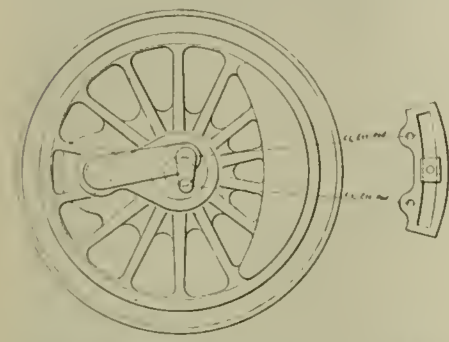
Filing Soft Metals.

The teeth of a file are soon filled when the file is used on lead, tin, soft solder or aluminum. It cannot be cleaned like the wood rasp by dipping it into hot water, but if the file and the work are kept wet with water, there will be no trouble as the already wet particles of lead soft solder, etc., do not readily adhere to the file.

The Anderson Valve Gear

A Double Eccentric Crank Arm, the Main Feature

As is well known valve gears have engaged the attention of the most inventive minds since the steam engine assumed its position as the leading motive power in mechanism. This restless spirit of a constant search for the ideal has resulted in many improvements and varied adaptations of the underlying principles essential to the harnessing of steam. On the steam locomotive the Stephenson valve gear, so called, held the leading place for more than half a century, but latterly with the great increase in the size of locomotives, and the limited space between the frames, it became a physical necessity that some form of outside gear should take the place of the cumbrous appliance and the result has been that various forms of outside valve gear are common in steam locomotive practice.

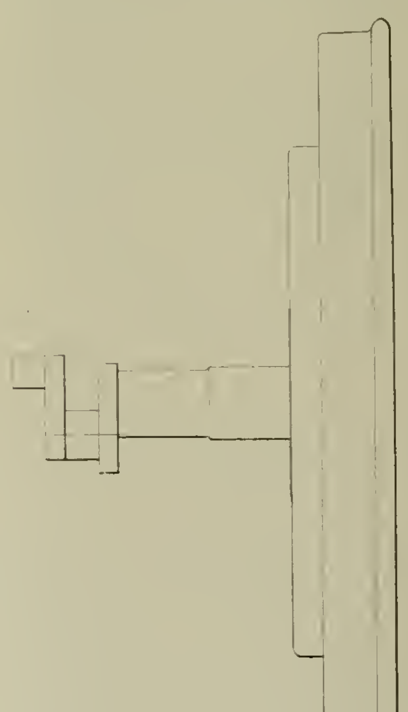


VIEW SHOWING DOUBLE CRANK ARM AND LINES OF CONNECTION TO SLIDABLE LINK.

It is not necessary to particularize their number and variety and advantages at this time, but to turn the reader's attention for a moment to a new design, the invention of Mr. J. A. Anderson, master mechanic of the Baltimore & Ohio Railroad, at Grafton, W. Va., which in point of simplicity in design and economy in construction seems worthy of the attention of all who are interested in the improvement of the mechanical appliances used on railroads.

As shown in our illustration the principal feature of this valve gear is a double crank arm fastened to the end of the main crank pin. This crank arm has two pins which take the place of eccentrics. They are placed in the following manner: key way points are located on axle, the same as for eccentric motion lines are drawn from center of axle, though these points and distances are spaced off equal to one-half the valve travel or the radius of eccentricity; then the crank arm is designed by having arms, so made as to connect up these points, the small arm being extended from the outer end of the pin on the crankpin arm; by so doing the connecting rods will not interfere when the axle is revolving. The motion is transmitted to a link similar to that used in the eccentric link motion, and continued to the valve by connection from link to valve rod, this being taken care of to suit the design of the locomotive. The link is raised and lowered to reverse the motion similar to the eccentric link motion. Of course, it is necessary for the tumbling shaft arm to be on the outside of the frame instead of the inside.

The advantages brought about by the gear, that is, made possible by the use of the double crank arm are its simplicity, and accessibility for inspection, oiling and maintenance. The improvement in this gear over valve gears located between frame with the eccentric motion are that it eliminates eccentrics, and straps which in turn reduce the amount of friction and does away with the heavy revolving parts. It also eliminates the heavy rocker boxes and long transmission rods which in most cases are curved and subject to considerable distortion. Of course, the doing away of these moving parts between the frames permits better bracing of the locomotive frame which in turn has a tendency to reduce frame breakages.



SECTION VIEW OF DOUBLE CRANK ARM IN MAIN ROD PIN.

The double eccentric crank arm is designed standard for each type of locomotive, being interchangeable from one locomotive to another of the same class and design. After once applying in accordance with specifications, there is no necessity for any changes or adjustments which are often necessary in the disk eccentric motion, due to loose or slipped eccentrics on axles.

In comparing this device with other outside locomotive valve gears, it has double crank arms which enable it to take all of the motion transmitted to the valve from the axle and secure a variable lead which in turn makes quick starting locomotives and better distribution of steam, without any connections to the cross head, and the elimination of these parts, and as already stated, the apparent merits of the valve motion in which the double crank arm is used is its extreme simplicity and accessibility for oiling, maintenance and repairs on account of it being an outside motion with variable lead, and reduced number of parts, the latter, of course, making it possible to reduce cost of construction.

Fuel and Power Resources of Canada.

In a recent paper before the Ottawa branch of the Canadian Society of Civil Engineers, Mr. John Blizzard reviewed the main sources of supply of heat and power in Canada. The most important is coal, of which some thirty million tons is needed each year. On account of the uneven distribution of Canada's coal, comparatively little being found in the central provinces of Manitoba, Ontario and Quebec, more than half the total requirements comes from the United States. Mr. Blizzard anticipates, however, that in the course of a few years this condition may be reversed, and the United States may be forced to seek coke and coking coals from Canada. Of the thirty million tons, it is roughly estimated that sixteen millions are used for power purposes—railway locomotives, nine millions; industrial power, six millions; collieries, one million; a total which, at 7 lbs. per h.p. hour, would be the equivalent of something over half a million continuous horsepower.

But the author goes on to point out that of the eighteen million continuous horsepower of energy in the form of water powers at present going to waste, some eight million is estimated to be within the present range of markets. This amount, making all allowance for transformation and transmission losses, would yield, say, a million and a half horsepower for traction and industrial uses—three times the present-day requirements.

The paper also outlines Canada's resources of wood as being very considerable; oil and peat in abundance.

Locomotive Development and Its Effect On Capacity

The development of heavy power units and large capacity cars in America has been a natural progression. It has been dominated by demands to move large heavy shipments long distances over varying grade conditions. The use of larger locomotives, making possible greater train loads, has been further influenced by increasing demands for higher wages on the part of all classes of skilled and unskilled labor that had to do with both the maintenance and operation of the power and, on the other side, by the limitation of revenue by adverse legislation. Improved designs and devices were introduced with the primary object of making possible the operation of power units of sufficient capacity to meet the heavy tonnage requirements imposed by American industrial conditions.

On thirty railroads of this country the average tractive power of locomotives increased 49.7 per cent. between 1902 and 1913. Progressing at this rate, physical limitations of height and width soon brought the length of the locomotive to its present extreme dimensions and further gain in tractive power had to be obtained by increases in the capacity of the locomotive boiler, which, in the early stages of the growth in size of the locomotive, was found to be one of the most important limiting factors. There were, necessarily, other circumstances which presented problems, but generally these could be traced to the boiler and their dependence upon the boiler could be established. Greater boiler capacity and, consequently, higher tractive effort was attainable, providing means of operating at overload for long periods of time, and reducing the drain on the boiler for a given power output, by effecting economy in the distribution and use of the steam or reducing the steam rate per horsepower hour.

Mechanical stokers of various kinds followed the efforts to obtain greater boiler power by using two firemen on the locomotive. It is most effective in increasing the capacity of the locomotive and its economy is realized in the resultant reduction of transportation costs.

The indirect means of improving the capacity of the locomotive, or that attained by increasing the economy of steam production and distribution, has accomplished much more than the direct methods. Compounding was employed, but this introduced maintenance complications which were not entirely worked out at the time, probably because other more effective means appeared which could be employed more readily and produce better results. It was discontinued for the time being except in the case of Mallet locomotives but will no doubt again come into use at a time when it will be advantageous to work out the entire solution of the problem.

The successful adaptation of the locomotive brick arch has also been a factor in improving the economy and consequently the capacity of the locomotive. It provided more complete combustion of the fuel, with consequently higher firebox temperatures and greater evaporation per pound of fuel burned.

There are many other devices that have been introduced, the purpose of which is to increase the capacity of the locomotive. Of these, the one which is recognized to have accomplished probably the most, toward making the present large power unit possible is the fire tube superheater. By the fuel and water economy which it effects it has extended the capacity of the largest locomotive that it has been practical to build within the physical limitations, up to at least 30 per cent over what it would have been had the attempt been made to operate it with saturated steam. It brought the heaviest locomotive within the capacity of the average fireman, and has proved to be a device suited to American practice on account of its low maintenance cost compared with the results obtained, thus going far toward offsetting the high wages of the American mechanic. Cylinders, limited in size by excessive condensation losses with saturated steam, can be designed to suit the governing conditions without regard for this factor when superheated steam is used, since there is ample protection against these losses.

Other details might be covered which are rather beyond the scope of a general discussion of this kind. However, summing up briefly the effect that the superheater has had upon the development of the locomotive it may be outlined as follows:

By virtue of a saving of 25 per cent in fuel and 30 per cent in water the capacity of a given boiler has been increased 1/3 and since the boiler capacity may be said to limit the hauling capacity, this latter has been increased proportionately. Nor are the possibilities covered by this, for still higher superheat and consequently greater extension in capacity are practicable. Two hundred and fifty degrees has been the maximum employed to accomplish the above mentioned results and it is well within the possibility of American locomotive practice to use successfully three hundred and fifty to four hundred degrees of superheat. For some time past a number of large passenger locomotives have been operated very successfully with steam chest temperatures of seven hundred and fifty to eight hundred degrees, or with superheat of three hundred and fifty to four hundred degrees and have given a proportionate increase in capacity over the general practice of two hundred and fifty degrees. The use of higher superheat is gradually becoming general and a corresponding increase in capacity of the locomotive is resulting.

Other means of effecting further economy and consequently extending the capacity of the locomotive are being developed and will prove of much value when in universal use. The feed water heater is among these and will conserve for useful work some of the heat now wasted from the locomotive boiler. The successful burning of low grade fuel by pulverizing will further extend the economies.

Locomotive Consulting Board.

Among the various boards of railroad men banded together under the new order of things appertaining to the railways under government control, Frank McManamy, manager of the Locomotive Section of the United States Railroad Administration, has appointed the following railroad officers as a consulting board to consider matters relative to the maintenance of locomotives, the distribution of locomotives to various shops for repairs, shop production and practices, and other matters of a similar character: H. T. Bentley, superintendent of motive power, Chicago & North Western; C. E. Chambers, superintendent of motive power, Central of New Jersey; C. E. Fuller, superintendent of motive power, Union Pacific; J. Hainen, assistant to the vice-president, Southern; D. R. MacBain, superintendent of motive power, New York Central Lines West; John Purcell, assisant to the vice-president, Atchison, Topeka & Santa Fe.

Supply Men's Association.

Announcement has been made that The International Railway Supply Men's Association will not make its annual exhibit at the forthcoming convention of the International Railway Fuel Association. This is in accordance with the request of the latter association, and it is also announced that there will be no exhibits of railway appliances, and no special entertainments will be held under the auspices of the Association.

Many have knowledge and still fail to accomplish. Ability to apply knowledge is the necessary factor for success.

Standardization in the engineering sense means the elimination of the unnecessary.

Handling Locomotive Coal.

Coal is one of the large items in the expense of railway operation. Not only does its first cost aggregate an enormous sum, but its transportation to points of use requires large equipment and demands operating service often sorely needed for other commercial purposes. Even though the first cost of coal at the mine may be reduced to a minimum by advantageous contracts with large coal companies and by other means, the final cost will also depend upon the cost of transportation. These words are practically those used in the bulletin No. 44 of the engineering experiment station of the Iowa State College. Our illustration affords a very good pictorial representation of how the cost of coal handling may be run up, especially at a small station.

It is necessary for the railroad to get coal to this point, and the high cost entailed is not an effectual deterrent. A small barge has to be loaded on one side of a lake and brought across, a gondola suitable for the reception of the coal has to be "placed," and a locomotive crane run to its "objective," as military men would say, and there operated. Our picture shows a crane picking up loads of coal with its clam-shell bucket and filling the car, which has then to be hauled to the engine shed and the barge sent across the lake again.

It is for these, and other reasons that railway companies are interested in knowing just where lies the economical limit of haul between any two coal fields, i. e., how far they can haul the locomotive coal from one mine until it becomes cheaper to use that from the next.

Pursuing this subject, the bulletin continues: The costs of locomotive coals per unit of power output do not depend alone upon the prices per ton at the mine, the ton-miles charged for in transportation, and the expenses per ton for handling; in addition to these there must be considered the relative values per ton of the coals as producers of power. Operating records will show the former costs, but the relative power-producing values of coals can be determined only by scientific tests under operating conditions.

This problem confronts many if not all of the trunk line railroads, and involves not only a comparison of Iowa coals with those from other States, but also a comparison of coals from different Iowa fields. Thus it is to assist in the solution of this problem that the Engineering division of this college has begun a series of tests in its new transportation laboratory, in co-operation with the Iowa railway companies. The first group of tests was in co-operation with the Chicago & Northwestern Railway, to aid in determining just how far they can afford to haul their coal from the Bend, Ill., mine toward their Buxton No. 18, Iowa, mine. The coals from both mines were compared by running a number of locomotive efficiency tests and by studying the firing and steaming properties. The coal was burned in a locomotive provided two years ago by the Chicago & Northwestern Railway Company for laboratory testing purposes. The bulletin can be had on application to the college.

Selecting Committees.

In what are called the "good old days" of railroad operating, the sending of committees to consult with general managers concerning grievances was very common and pets of fossilized general managers worked their way in to be representatives of trainmen. When that practice was at its height, an old railroad man named Cyrus Warman became editor of a railroad paper, and he proceeded successfully to root out the practice of appointing on committees what he termed labor trouble quacks. On this subject he wrote:

"Brothers, when you send a committee up to see the 'old man,' pick out the best men on the whole road, men who have good records of service to the company, and whom you are sure the officers respect and will listen to. Don't pick out men noted for talk or bluster and whom you know are obnoxious to the officials, who by their very manner will offend most men and put them on the defensive. Send gentlemen to meet gentlemen, and business men to do business; send them to argue your case, make offers, open negotiation, and make contracts as other business men do, not to bluff and bluster and threaten and browbeat to secure that which reason could obtain. The best engineers and firemen on the road are none too good to meet the officers of the road in a test of argument."

The Fuel Problem.

Dr. Noyes, of the Fuel Administration department, says that there is no use of producing coal—taking it out of the mines and piling it around the mouth of the mine. It is better to go down into the mine and get it with the machinery available than to raise it when there are no cars to put it in. If that is so, and it seems entirely probable, the coal in the mine is ready to be taken out and is being taken out as fast as cars are put there to receive it. The railroads of this country distribute a large proportion of our coal, about 85 per cent., and nearly 35 per cent. of the entire freight they haul is coal. No wonder we would like to fill the coal bin just to have the coal, but we would like also to get rid of the job of hauling it. We need the railroads for other things, not only for hauling food, but for materials which go into munitions. The problem of distribution is, after all, one of the most serious problems in connection with the fuel problem at this moment.

Combustion.

Most firemen learn the art of firing in the hard school of experience. Learning by practice alone is a kind of groping in the dark; theory should illuminate the track so that with fewer journeys the traveller may become familiar with the way. Therefore it is hoped that this explanation of the laws of combustion will aid the junior firemen in their work and will also be helpful to the senior firemen for examination purposes. Carbon is an element which forms about four-fifths of weight of coal. Oxygen is an element which forms about one-fifth of the total volume of the atmosphere. Combustion is the chemical union of carbon and oxygen, whereby heat is evolved.

This chemical union produces either of two gases, according to the proportion in which oxygen is united with carbon. When each atom of carbon is united with one atom of oxygen, carbon monoxide (CO) is the gas formed. When each atom of carbon is united with two atoms of oxygen, carbon dioxide (CO_2) is the gas formed. The quantity of heat evolved in forming CO_2 is three times as great as the heat evolved in forming CO. This additional heat is obtained simply by using up more oxygen, which costs nothing, and does not require to be shovelled into the firebox.

A temperature of about 1210 degrees F. will enable each atom of carbon to unite with one atom of oxygen; but before it can unite with two atoms of oxygen a temperature of about 2500 degrees F. is required. Therefore the essential conditions for the formation of CO_2 are:—(1) Sufficient air must be got into the firebox to supply two atoms of oxygen to each atom of carbon; (2) the temperature must be very high to cause them to unite when brought into contact.

Coal is divided into two main classes viz., anthracite and bituminous; when a fresh charge of bituminous coal is placed into the firebox, a much larger percentage of coal gas is given off than in the case of a similar charge of anthracite. Therefore, when using bituminous coal (such as Maitland), it is advantageous to run with the firedoor open a notch or two to furnish additional oxygen so as to convert the coal gas into CO_2 before it gets away through the tubes and is lost.

Sellers Injectors.

This injector was patented by Henri Giffard, a French engineer, in the year 1858, and was introduced into British practice by William Sellers and Company in 1860. In the early form both the water and steam were regulated, but the necessity for frequent adjustment of a new type of fixed nozzle injector, which combined a system of

automatic adjustment of the water supply. This injector is simply constructed, consisting of three separate cones in one mounting, the steam cone, combining cone, and delivery cone. At the end of the delivery cone is a non-return valve, which acts as a check in case the boiler clock valve blows back. All valve seats that need refacing can be removed.

To put this injector into operation the water valve is opened, then the steam from the boiler is admitted to the lifting nozzle by drawing the starting lever out about one inch, which does not withdraw the plug on the end of the spindle from the central part of the steam nozzle. Steam then passes through the small diagonal holes, and by the outside nozzle, through the upper part of the combining tube, and into the over-flow chamber, lifts the overflow valve and escapes through the waste pipe. A vacuum is then created in the body of the instrument, which causes the water to lift, the starting lever is then drawn back, opening the steam valve wide, and a full supply of steam is discharged into the combining tube, forcing the water through the delivery tube into the boiler.

All injectors having side openings in the combining tube, at high steam pressures a large amount of vacuum is created in the overflow chamber. Now in the improved self-acting injector these holes are utilized to draw in an additional supply of water into the combining tube by way of an inlet valve, which works automatically. When this extra vacuum is created, this additional water increases the capacity about 20 per cent.

A cam lever is turned towards the overflow valve, and is mostly used when the strainer requires cleaning out with the steam from the boiler. To tighten up the gland of the steam spindle or repack it, push in the starting lever to end of stroke, take off the little nut on end of spindle, disconnect the side links, then draw back the lever. This frees the crosshead, which allows the follower to be tightened up a gland repacked. This can be done very easily and quickly when on the road.

The action of the injector is due to the high pressure with which a jet of steam strikes the water entering the combining tube, imparting to it its momentum and forming with it during condensation a continuous jet of smaller diameter, having sufficient velocity to overcome the pressure in the boiler and so automatically maintain the supply of water. The condensed steam and water together form a comparatively heavy body moving at a velocity sufficient to overcome the inertia of the standing water in the boiler. This fact has, when turned to account, been of the highest value in the engineering world.

Correspondence

Lining Up Locomotive Guides.

By J. E. Cromwell.

As stated in an able article recently published in Railway and Locomotive Engineering, there are various methods in vogue in railroad repair shops in the lining up of locomotive guides, and I would state briefly the method that is in use by our leading machinists. The first step is to see that the back cylinder head is securely fastened in place with guide blocks plumb with center of cylinders. This condition can be checked by finding the center of each lug and measuring from these centers to the locomotive frame. Care should be taken to see that the joints of both the cylinder and cylinderheads are true and clean before applying the cylinder head. Then see that the back guide blocks or knees are firmly secured to the guide yoke in the central position. Then place the bottom guide in position, securing it in place by temporary bolts. The crosshead may now be placed on the bottom guide. A center line should now be run through the cylinder by fastening a stick to one of the upper front cylinder head studs, the stick being provided with a slot in the lower end. Insert and fasten a string in the slot, passing the string through the cylinder and crosshead, securing the end of the string to the guide yoke or frame by means of a stick and clamp or some similar device. Locate the line in the center by calipering from front centerbore of the cylinder and stuffing box in the back cylinder head, taking care to have all calipering surfaces free of dirt and carbon. This location of the center line is used for new installments.

In regard to work where the parts are worn, the center line must be relocated. If the cylinder has not been rebored, and piston head is old, that is, if no changes have been made, then caliper the distance from the piston and center to the lower part of the piston head with an hermaphrodite caliper or some similar tool. Locate the center line by this measurement from the bore of the cylinder at the bottom portion of the cylinder, making it parallel with the original central line. Use this new center line for locating the bottom guide by measuring the distance over the crosshead shoes, and setting the guide one-half of this measurement below it.

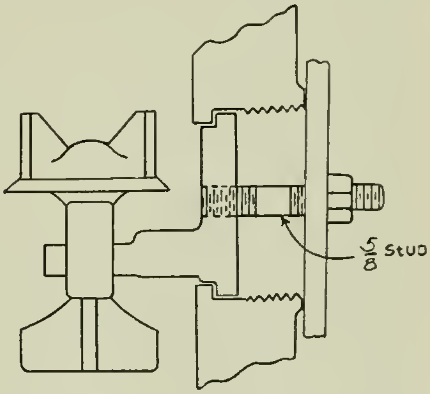
To line the crosshead and guide bars both vertically and horizontally, the crosshead must be pushed to both the front and back ends of guides, and the cylinder center line must be found in the center of the piston rod fit, the exact location being found by the use of inside calipers. The top guide may now be set in position, and lining necessary to place it properly should be done before the holes are drilled and reamed. The location of the guides should then be checked from the frame to know that they are in right alignment. One side of the guide bar may be held temporarily with bolts or clamps, while the other side is being drilled and reamed. The reamer used for this work should be a standard locomotive reamer—that is, 1/16 in. taper to 12 ins. After all holes are reamed and bolts are fitted to guides, they should be drawn in and nuts drawn up tightly.

Removing Stuck Eccentric Spindles From Monitor Injectors.

By F. W. Bentley

Missouri Valley, Iowa

The eccentric spindles of Monitor injectors are sometimes very hard to get out, when they are set by the corrosion and lime accumulating in the water end of the injector. These spindles with the attached loose valve controlling the water are frequently not worked enough to keep the spindle loose and the above is the result



SECTION VIEW OF DEVICE FOR REMOVING ECCENTRIC SPINDLES FROM MONITOR INJECTORS.

of it. The spindles can of course some times be loosened by tapping the handle end of the same after the bonnet and nut have been removed. Nevertheless in many cases the handle end is broken in this attempt too, leaving only the flat disc and surface of the spindle to work on, as the water valve below will allow no direct or effective access to it from below.

The sketch shows how a hole can be drilled in the center of the disc to take at least three or four full threads of a 5/8-in. tap. By means of a short 5/8-in. stud and a nut the old spindle can be quickly jacked out against any kind of a plate laid over the water valve bonnet cavity. Unless one has been up against one of these stuck spindles, it is almost impossible to conceive how firmly they can become corroded. The above is about the quickest and the easiest way to get them out that the writer has ever seen practiced and it has been of much to us on many occasions.

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Standardization.

Last month we pointed out that the most satisfactory form of standardization was that applied to freight cars. That form in its most desirable shape had been brought about by an evolutionary process; and every one knows that evolution is not an instantaneous event, but that it requires time. Some day we may get a form of car-coupler which will be so far ahead of all its competitors as to stand alone and be in a class by itself. We have not reached that degree of perfection at present, but the whole tendency of the process we have adopted, is necessarily leading forward: first, by the elimination of undesirable forms, retaining only those that stand the service test. This is the survival of the fittest, and second, by leaving the way open for new ideas, fresh inventions, and the applications of discovery and experience. That is the supply of new matter at the top, while the process of elimination goes on at the other end. A car-coupler with only the contour and a few dimensions, considered as obligatory, permits a variety of new ideas to have a trial, and the subsequent failure of any one of them means its automatic removal from the field. To hinder this process or to stereotype its action is to invite lethargy and stagnation.

The Government requires engines and cars in large numbers and in short order. This increase in power and in vehicles is needed because of the heavy congestion of freight traffic where the product of munition factories and other Government industries, crowd outward to the sea. All the railway lines all over the country are not equally congested. Some zones are comparatively free from over-crowding. The idea is to take engines and cars from the less crowded districts and use them on the overworked lines. This is right and proper, and a good move in an emergency, but the conditions we see and the reasonably accurate forecast we can make, leads us to apprehend that what confronts us is not so much of an emergency, sudden as its rise has been; but it is a severe condition that does not show signs of early abatement.

Viewing this as a severe condition rather than a mere emergency, the powers that be may well look about for a solution of the problem, and not merely a speedy and adroit action to get a prompt temporary result. It is like hurriedly applying a home-made tourniquet to a wound, instead of having a surgeon find and close the ends of the severed artery. Although the railway situation cannot be likened to a wounded man, yet the analogy holds in so far that bad practice at the start may leave a scar or a legacy of trouble for later days. More engines are required for use in the congested districts. Let that be granted. Under the natural law of evolution, each railway in this district, and out of it for that matter, has been buying the form and style of engine best suited to its own needs. Those railways which require more power are not worked up to their full track capacity, and they might be asked to state how many additional engines they need. The builders could also state their maximum capacity for the remaining months of the year, and a percentage allotted to each of the congested roads, if their complete requirements could not be met.

As to the style of engine to be delivered to each road: each has, as we have pointed out, bought the engine most serviceable on the road, be it flat and level or hilly and full of curves. No strictly uniform style of engine can be made to fit conditions, varying as they do from one road to another in America. Each road has its "ideal," or its "best" engine, probably the latest received from the builders. A percentage has, let us say, been allotted to this road. What more natural than that each road should order the last and best style it knows of, where the builders have approved drawings, the requisite patterns, the forging dies, the forms for pressing steel shapes, and a complete bill of material on the table before them. If they cannot supply these engines promptly nobody can, and when delivered the railway has the engine of its own choosing with plenty of repair parts in stock.

An arrangement could be made whereby the builders would exclusively build, and each railway keep up its stock of repair parts, and make repairs, without loss of time. By this arrangement builders and railways would know exactly what was expected of them, and moreover, each would be doing what it is admirably fitted to do. Aptitude to do work, and definiteness of aim, must produce a saving in time which would be most important just now. At the close of the German war, or when congestion abates, a railway having received the kind of engine it would have bought for itself, is better off than if a new style had come to it with new repair parts to be kept in stock. If the Government chose to design, say four styles of engines, with such characteristics and such construction as would give each type a wide range of territory in which it was not only available, but satisfactory; well and good, progress would have been made, difficult of design as such an engine or engines would be. The type, however, would stand for future or present use or for reference, as the Government "general utility" engine, optional with builder or buyer. Such a series of engines might fill a niche that has long been vacant, but the previously outlined plan would probably be the more expeditious of the two. The effective production of rapid and efficient transportation is the desideratum, and we believe the Government is animated with a most sincere desire to do the right thing, the wise thing and the supremely efficient thing, and though we do not claim to have here found the way out of the present transportation maze, or the philosopher's stone, we have ventured to put forward what seems to us to be one worth thinking about.

Necessary Action.

We have had the pleasure of quoting the official utterance of a most capable, trustworthy and painstaking body of investigators, on the cause of railway accidents. We refer to the Interstate Commerce Commission. The men forming the personnel of this commission have no interest, pecuniary or otherwise in the adoption of what they recommend. They have examined the varied causes of railroad wrecks with the usual saddening accompaniment to the disaster of loss of precious human life. Apart from the failure of mechanism, which is relatively small, one fact stands out clearly, and it is emphatically mentioned by those who have the matter of investigation in hand.

The fact that they make clear, though they do not state it in so many words, is that man is really an imperfect machine. In the chapter on "Attention," Prof. B. B. Breese, in the pages of his work on Psychology, says: "First come our native interests—food, shelter, intense stimulation, bright lights, loud sounds, moving

things, etc., and last of all, our acquired interests—art, literature, science, our professions, occupations, etc. Our acquired interests rest mainly in those things with which we have become familiar through voluntary attention." What we have learned last we forget first. To give this a concrete application, the watching for, and interpreting of, signals by an engineman is necessarily acquired interest and is not so sure or permanent as those interests which have been stamped into the very fibre of man's nature in the now far distant days when the race was in its early formative stage. Man with his many good intentions cannot always go right.

This fact has been recognized by the Interstate Commerce Commission, and they have stated that some form of train control is necessary—that it is, in fact, a duty owed by the railways to the travelling public, to provide an adequate system of automatic train control. So far their remarks have been advisory. We now find that the commission is part of the "owning" and operating power. The call of the duty to the travelling public is the same now as then. The government has set aside some $500,000,000, which has been called a revolving fund, and this money is "to provide terminals, motive power, cars, and other necessary equipment."

This wording looks as if the only requisite remaining now is to show that an efficient system of train control comes within the meaning of the phrase, "Other necessary equipment." The majority of railroad men, both executive officers and the rank and file, would, we believe, most unhesitatingly hold that it does, the Interstate Commerce Commissions says that providing such equipment is a duty. How will the necessary action be brought about now?

The Director General of Railways says that Progress and America are synonymous terms. They ought to be synonymous, but if they are they do not represent a fixed condition, or a constant ratio. These words can only be made synomyous by constant adjustive action. Mere statement or flowery rhetoric will not produce the result. It is a matter of satisfaction that at this juncture the Director General does not seek to throttle initiative or stifle enterprise. There are many ways that progress can be made. The Government acting on expert advice must draw a definite line of demarkation between the important and the unimportant. The train control idea—the duty spoken of by the Interstate Commerce Commission—is one of the most important actions that can be taken; for it means preserving the lives of citizens, in an era of prodigal and unparalleled waste, brought into our lives by the hideous German thing—waste as colossal as it it unnecessary. These things turn our minds to sensible conservation in all things—most of all in precious human life. If Progress and America are to be synonymous, they must be made so by some definite act. Now is the time to go seriously about doing the act.

Rhode Island Coal Pulverized

The following piece of information has been received from the president of the Locomotive Pulverized Fuel Company, of New York, and although it does not directly refer to locomotive practice, it helps to direct attention to the increasing use of very fine coal for steam making in locomotive or stationary practice, which is one of the features of our economic development as a nation. There is no doubt that the whole subject of the use of pulverized coal is one of national importance, now more than ever before. This successful use under stationary boilers of a somewhat refractory anthracite coal points to the day when it may be burned with every satisfaction in a locomotive firebox. This coal can be used in locomotives when mixed in the proportion of 60 per cent R. I. anthracite and 40 per cent bituminous.

The United States Geological Survey Professional paper, No. 100-A, on "The Coal Fields of the United States," remarks as follows: "The Rhode Island anthracite region, although known since 1760, is of little economic importance, for the coal has never been mined for a long period on a commercial scale, and judging from its composition and the metamorphism of the surrounding rocks, it seems doubtful whether it will ever have more than a local value, if it is worked at all. The coal is more highly metamorphosed than that of Pennsylvania, so that some of it is mined and sold as graphite. It also carries a large percentage of ash, which makes it an expensive fuel to mine and to use."

United States Geological Survey Bulletin No. 615, on "Rhode Island Coal," states of this coal as follows: "Rhode Island coal is a high-ash, high-moisture, graphitic anthracite coal of high specific gravity. A careful test in actual practice showed Rhode Island coal to have 72 per cent of the efficiency of Lackawanna coal." Rhode Island coal has had a perennial interest for the people of that State and for outside coal and iron men and promoters. Its situation directly on the seaboard and in the center of a region of dense population and large manufactures, gives it a great advantage in the New England markets over other coals through reduced cost of transportation, an item that adds largely to the cost of the coals with which New England is now supplied.

The attempt to burn this Rhode Island coal or to treat it as other coals have been treated has usually been unsuccessful, but if it is properly prepared and properly handled, it appears to have possible uses. Its high content of water requires that it be seasoned under cover before it is used, and its commonly high content of ash is adverse to its shipment for use at distant points. The attempt to burn Cranston coal in large sizes, fresh from the mine, in an ordinary furnace is doomed to disappointment. Rhode Island anthracite may be employed for household use, steam production, metallurgic work, briquetting, brick burning, and similar work, the manufacture of water gas or producer gas for use directly or for power production.

The coal upon which a test was made, was some of the by-product from the Cranston mine operations on a tract located immediately south of Providence, R. I. This coal was mined near the surface and is not of very good quality. This Rhode Island anthracite, before preparation, had been laying on the ground exposed to the severe weather conditions, and contained 18 per cent moisture.

The first test of this coal was made in connection with a 465 H. P. nominal rating Stirling type of stationary boiler, which was being regularly operated with the Pennsylvania pulverized anthracite. About six tons of the Rhode Island anthracite, in pulverized form, was merely substituted during the regular operation, without any chage in the feeding or burning equipment or furnace, or of any operating adjustments, for the Pennsylvania anthracite, for the purpose of making a general comparison of the combustion results. No difficulty whatsoever was experienced and the combustion was very satisfactory, in fact, apparently better than with the Pennsylvania anthracite. The next test was made under the same boiler for the purpose of determining the relative combustion and boiler efficiency, and a careful tabulation we have seen shows the use of the Pennsylvania anthracite birdseye and the Rhode Island anthracite by-product under approximately like equipment and operating conditions. The Rhode Island anthracite burned in practically the same manner as the Pennsylvania anthracite, but there was a greater accumulation of ash in the slag-pit. The relatively low boiler-horsepower was due to the use of feeders of too small capacity for high ash coal.

It is stated that with the new means and methods now developed there seems to be no reason why this Rhode Island anthracite should not be mined on a commercial basis and utilized to release fuel oil, Pennsylvania anthracite and bituminous coal, now being transported by rail and vessels into the new England district for industrial steam generation and heating purposes, as the inability to effectively and economically utilize these fuel deposits up to this time has been due to the lack of the proper method for its preparation and burning.

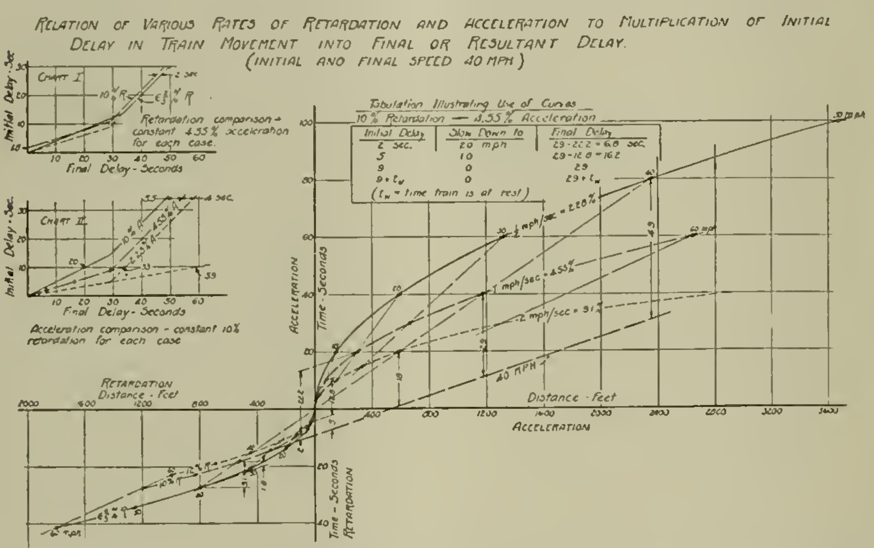
Air Brake Department

Relation of Various Rates of Retardation and Acceleration to Multiplication of Initial Delay in Train Movements Into Final or Resultant Delay.

By WALTER V. TURNER, Assistant Manager, Westinghouse Air Brake Company.

This subject has been touched upon in the previous issues of this paper with a view to setting forth a system of proper spacing between trains in congested districts, such as the New York subways, and as there is insufficient space in a publication of this kind to deal with such a subject in a single issue, an effort has been made to deal with all of the various phases of the subject in several different articles, each one being in itself as complete as is possible to make it.

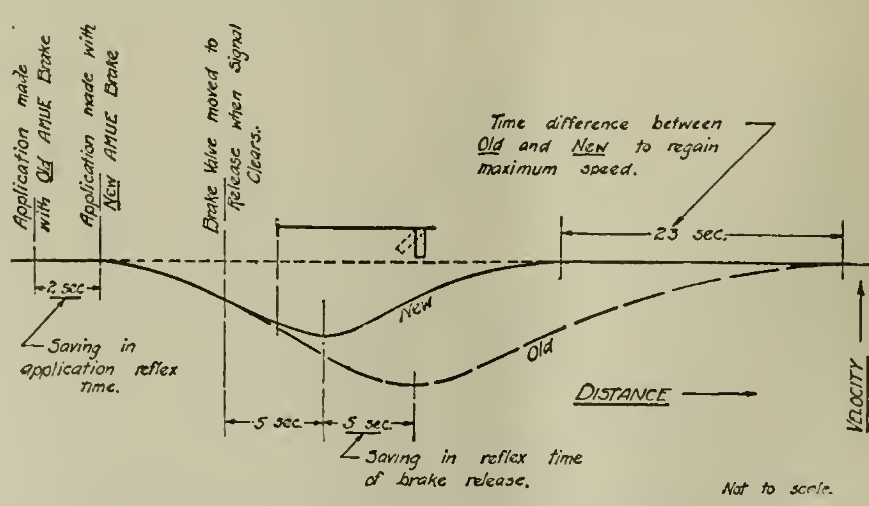
At the present time it must be assumed that the reader has been sufficiently interested in the subject to have studied the diagrams previously printed, and in connection with the diagram in this issue, No. 1, Chart No. 1, compares the various retardation rates on the before-mentioned delay, multiplication when the acceleration is constant. With the higher retardation rate, braking commences later, other things being equal, and effect the same result obtained by the lower rate of retardation. In the comparison made between a 6 2/3 per cent and a 10 per cent retardation, the latter was therefore given an advantage of 1.8 seconds, determined by construction as shown by the main figure, that is, the 6 2/3 per cent train had to retard 1.8 seconds before it was necessary for the 10 per cent train to start retardation. However, the curve for the latter in chart 1 crosses the former twice, first overtaking it (the 6 2/3 per cent curve) because of greater effectiveness of the brake and then receding from it beyond the jog in the curve because of coming to a stop in reduced time. The two curves finally parallel one another with a total delay difference of two seconds in favor of the better brake. The dotted curve makes the comparison without allowing the 1.8 second handicap.



An initial delay to a train is multiplied several times before the train is running again at normal speed. This final delay becomes the initial delay for a train following under minimum headway, and the cumulative effect is to disorder the whole system of trains unless ample headway be allowed to absorb unavoidable delays before they influence succeeding trains.

A tabulation is given illustrating the method of using the data taken from a dimensioned main curve to relate the initial to the final delay. The example given is the one involving constant rates of retardation and acceleration of 10 per cent and 4.55 per cent respectively. The other rates are handled in a similar fashion.

Chart 2 of Fig. No. 1 shows the relation between various rates of acceleration in this matter of multiplying the initial into final delay, with the rate of retardation constant at 10 per cent, in order to have but one variable in the problem at one time. Up to the point of coming to a complete stop (indicated by the jog or turn in each curve) the 10 per cent acceleration rate gives a multiplication factor of two, the 4.55 per cent (one mile per hour per second) a factor of 3.3 and the 2.25 per cent rate multiplies the initial delay by 5.9 into the final delay. As is to be expected, the better the acceleration the less the final delay.



GRAPHICAL ILLUSTRATION OF WHAT THE SAVING IN REFLEX TIME OF BRAKE APPLICATION AND RELEASE MEANS TO THE OPERATION OF TRAINS.

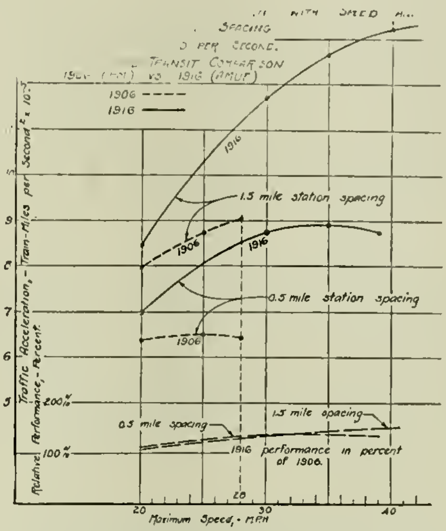
Any other speeds than 40 miles per hour may be investigated in like manner for delay multiplication. The lower the speed the less multiplication will be, other things remaining the same, for obviously, the less accelerating and retarding there will be to do. The reverse is true of higher speeds.

The value of the new electro-pneumatic brake may now be well appreciated in its saving of 2 seconds time in reflex time of brake application (time from brake valve movement to rise in brake cylinder pressure) and its release of brakes in 5 as compared with 10 up to 17 seconds. This time saving amounts to from 5 to 12 seconds for release and adding the 2 seconds application saving, the total saving is from 7 to 14 seconds. In slowing down for a signal it is as necessary to get the brake off as it is to get it on, under conditions

where in train operation, the second is the unit of time schedule, and the delayed necessity for applying the brakes may mean in many cases no necessity for applying at all, because the signal may go "clear" within the two seconds which are saved in reflex time. Therefore, the total saving in initial delay of from 7 to 14 seconds means a final total saving of from 14 to 40 seconds resultant delay, depending upon the multiplication factor applying in the particular case. If the minimum saving of 7 seconds be taken with the acceleration rate of one mile per hour per second, which is higher than actually realized, and with a 10 per cent retardation rate, according to Chart two, Fig. 1, the saving in final delay is about 23 seconds. A 23-sec. initial delay for the following train is multiplied into 43 seconds final delay, and this as initial delay for the third train and so on. The significance of the 7 seconds having become apparent in its cumulative effect on succeeding trains. This presupposes, of course, that trains are following each other under minimum headway, and the necessity for allowing a delay or safety factor in the headway actually used is again emphasized. Fig. No. 2 is a graphical illustration of the foregoing points, and while not drawn to scale, it supplements Fig. No. 1 in picturing the time lost before a train which has been slowed down can get back to speed, and the value of a brake which eliminates reflex time to the maximum degree.

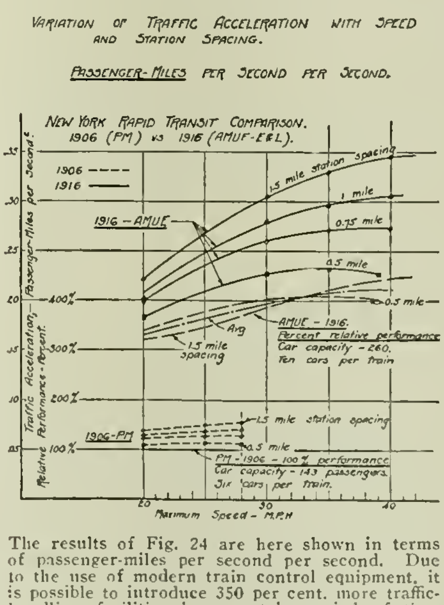
Figs. 3 and 4 were prepared to compare the traffic capacity theoretically possible in 1906 on the rapid transit lines in New York City with that now possible. Fig. 4 shows a gain of 350 per cent in traffic performance which is a comparison of 350,000 with 1,350,000 passengers handled daily. Though the values of these curves are not of any actual state of affairs, because account is not taken of any local conditions, and practical operating allowances, they are interesting for the theoretical maximum limit which they point out, nevertheless for comparative purposes they are of as much meaning as though they were in the first place, practical instead of theoretical values.

The traffic capacity unit of these curves is the train mile or passenger mile per second per second. This is an acceleration unit representing the increase in traffic handling facilities which can be made in unit time to care for the peak loads in rush hours. This acceleration unit is found by dividing the average or schedule speed over a given distance (including station stops) by the headway. If the average speed Vs be in miles per second and the headway Hs be in seconds per train, the quotient will be "train miles per second per second." The corresponding unit "passenger miles per second per second" is found by multiplying the train mile factor by the train capacity in passengers. This factor stands in the same relation to train miles and time that acceleration, as generally known, stands to space and time. T just where velocity equals acceleration times the time, the number of train miles per second operating at any instant



The average or schedule speed of trains in miles per second over a district divided by the seconds headway intervening gives a traffic acceleration unit—train miles per second per second. This is a measure of the ability to get trains into operation quickly to care for peak traffic loads. Modern brake equipment has rendered possible an increase of 50 per cent. over 1906 performance in the number of longer trains it is possible to introduce into operation in a certain period of time.

equals the traffic acceleration factor multiplied by the time during which it has been in play. Of course after a railway system has become completely filled with trains, a maximum velocity, or number of



The results of Fig. 24 are here shown in terms of passenger-miles per second per second. Due to the use of modern train control equipment, it is possible to introduce 350 per cent. more traffic-handling facilities in a certain period of time than was possible in 1906.

train miles per second, has been attained and more trains cannot be introduced, also as the number of points for introducing trains is increased, the portion of the entire railway system per point is decreased, and therefore the time for filling to maximum capacity is also decreased.

In this it is to be understood that the term "railway system" applies to that portion supplied from one point. Many interesting analogies will come to mind in the consideration of this newly evolved acceleration factor, and mathematically these analogies may be summed up as,

SPACE.

1. $v = vo + at.$
2. $s = vot + \frac{1}{2}at^2.$
3. $v = vo + \sqrt{2}$ at.

where,

v = velocity, feet per second.
a = acceleration, feet per second^2.
t = time, seconds.
s = space, feet.
vo = initial velocity at beginning of time t.

TRAFFIC.

1. $V = Vo + At.$
2. $M = Vot + \frac{1}{2}At^2.$
3. $V = Vo + \sqrt{2AM}.$

where,

V = train miles (or passenger miles) per second.

$$A = \text{train miles per second}^2 = \frac{Vs.}{Hs.}$$

Vs = average speed over district, miles per sec.
Hs = headway between trains in seconds.
t = time in seconds.
$2M$ = train miles (or passenger miles).
Vo = M per second at beginning of time, t.

In 1906 PM brake equipment was in use, which set an operating limit to train lengths of 6 cars and cars were 51 ft. in length. Today the electro-pneumatic empty and load brake (designated AMUE-E&L) is the last word in control equipment, which sets no limit as to train length, but station platform can accommodate trains not longer than 10, sixty-seven-foot cars. The car capacity was then 143 passengers, as compared with 260 now, an improvement due in no small measure to the empty and load feature for uniform rates of retardation and acceleration irrespective of the condition of the car loading.

For different conditions of uniform station spacing the schedule or average speed (Vs) in miles per second will be determined by the distance from one station to the next in miles, divided by the sum in seconds of the times of acceleration running at maximum speed, deceleration and station stop.

Locomotive Air Brake Inspection.

(Continued from page 123, April, 1918.)

308. Q.—What is meant by the term flexible when used in connection with air brake matters?

A.—It means more readily responding to the will of the operator or the engineer.

309. Q.—It has been previously stated that the difference between the condition

of the two portions of the distributing valve would be manifested during this test; what would be wrong if the brake could be graduated off in steps of 5 lbs. at a time, but the brake would not apply with a 5-lb. brake pipe reduction when the brake valve test was started. Standard equipment?

A.—The trouble would be with the equalizing portion of the distributing valve.

310. Q.—What would you think was wrong with the brake if it would not completely release at this time, but instead a "blow" continued at the direct exhaust port of the automatic brake valve and this blow occurred only at this time?

A.—It would indicate that there was excessive friction in the application portion of the distributing valve and that the packing ring was stuck in the groove of the application piston, or leaking very badly.

311. Q.—What would cause the continued blow or where would this waste of compressed air be from?

A.—From the main reservoir through the brake cylinders and into the application cylinder and from there through the brake valve exhaust port.

312. Q.—Is there any other reason why the application portion of the distributing valve should at all times be sensitive?

A.—Yes; if there is considerable friction or resistance to the movement of the application portion the brake may remain applied after a light brake application with no air pressure shown on the gauges.

313. Q.—How could this occur?

A.—A very light reduction, possibly through leakage and a not sufficiently sensitive feed valve, may result in a very light brake cylinder pressure merely enough to hold the brake pistons out with the shoes against the wheels and not enough to move the application piston and attached valves to release position.

314. Q.—Could this occur with leaky brake cylinder packing leathers or leaky pipe connections?

A.—No.

315. Q.—Why not?

A.—Because the brake cylinder pressure would not be maintained with the application portion of the distributing valve in this position and the brake cylinder leaks would allow the release springs to return the brake pistons to release position.

316. Q.—What would be the probable result of such a brake action if the packing leathers and pipe connections of the brake cylinders were free from leakage?

A.—Overheated driving-wheel tires.

317. Q.—What would the heating likely result in?

A.—Loosening the tires on the wheels.

318. Q.—Do you make an automatic application of the brake while the independent brake is fully applied during a test?

A.—No.

319. Q.—Why not?

A.—It is unnecessary and results in an overcharging of the signal pipes.

320. Q.—How so?

A.—When the independent brake is fully applied with the handle in slow application position, the reducing valve pipe and consequently the branch to the signal line is in communication through the independent brake valve and an automatic application increasing the application cylinder pressure will also tend to increase the pressure in the signal pipe.

321. Q.—How is this action shown by the air gages?

A.—After the automatic brake application that builds the application cylinder pressure up to 60 or 65 lbs. ceases, the brake cylinder pressure shows a drop by the hand of the gauge while the distributing valve exhaust opens showing that there has been a drop in application cylinder pressure.

322. Q.—What is the next movement during the test of the locomotive brake?

A.—After completing the graduating off, the handle is moved to quick application position.

323. Q.—For what purpose?

A.—To ascertain the time required to obtain 40 lbs. brake cylinder pressure in quick application position or if a quick application of the locomotive brake becomes necessary.

324. Q.—How long would this take?

A.—From 2 to 4 seconds time.

325. Q.—What is the difference between the terms "application" and "reduction?"

A.—A reduction in brake pipe pressure is understood and an application dates from the time the brake is applied until it is released so that an application may consist of any number of reductions.

326. Q.—How many applications of the brake have you then made with the brake valves during the entire brake test of the locomotive?

A.—Two applications with each brake valve.

327. Q.—Explain just what movements you have made during the inspection.

A.—Closed the stop cock in the distributing valve, passed through under the engine from the pilot to the rear of the tender, passed around the engine once, and entered the cab to complete the inspection.

328. Q.—Under ordinary conditions when nothing but the ordinary run of johs are found, about how long should it take an experienced inspector to make the entire inspection.

A.—Approximately 15 minutes time.

329. Q.—What would you think if an inspector would make the inspection in somewhat less than 10 minutes?

A.—That the inspection was not properly made.

330. Q.—What if it required considerably more than 15 minutes?

A.—That a great deal of time had been lost at some point of the inspection.

331. Q.—Does this complete the air brake inspection?

A.—Yes.

332. Q—Heretofore the E. T. equipment only has been considered. What is the difference in inspecting a locomotive equipped with the New York L. T. brake?

A.—It is to be inspected in the same general way, but the brake cylinder leakage is made in a different manner, and the names of parts and piping are somewhat different.

333. Q.—How is the brake cylinder leakage test made?

A.—By applying the straight air brake in full and returning the valve handle to lap position.

334. Q.—What then indicates brake cylinder leakage?

A.—The fall of the red hand of the small air gauge.

335. Q.—Can this leakage test be made in a different way?

A.—Yes; by making a full service application with the automatic brake valve and closing the stop cock in the control valve supply pipe.

336. Q.—In either case will communication with the brake cylinders be closed?

A.—Yes; in both cases.

337. Q.—What is the name of the pipe that acts for the control valve in the same capacity as the application cylinder pipe for the distributing valve?

A.—The control pipe.

338. Q.—The name of the one that serves as the release pipe?

A.—The retain pipe.

339. Q.—Which one is the control pipe?

A.—The lower one of the copper pipes at the right hand side of the control valve reservoir.

340. Q.—Where does it lead to?

A.—To the automatic and straight air brake valves.

(To be Continued.)

Train Handling.

(Continued from page 124, April, 1918.)

329. Q.—Why?

A.—To prevent the possibility of the brake being applied in quick action on the charged cars.

330. Q.—How could the brake pipe pressure be reduced quickly and heavily enough to cause emergency operation?

A.—By opening the angle cock too suddenly.

331. Q.—Why is this undesirable at any time?

A.—It tends to do a great deal of damage to certain types of foundation brake gear and tends to throw dirt and foreign substance from the brake pipe into the brake cylinders and car brake operating valves.

332. Q.—Why is it very desirable if a prompt movement is necessary?

A.—It requires a much higher brake

pipe pressure to effect a release than if service operation resulted from the coupling up.

333. Q.—How much brake pipe pressure will be required to release a P. M. equipment after an emergency application?

A.—A trifle over 60 lbs.

334. Q.—Why not more?

A.—Because the high speed reducing valves will reduce the auxiliary reservoir pressure to 60 lbs.

335. Q.—How much pressure to release the Universal valve after an emergency or quick action application?

A.—About 90 lbs.

336. Q.—Why?

A.—Because this is the equalizing point of the service and auxiliary reservoirs with the brake cylinder.

337. Q.—Why is the pressure in the service and auxiliary reservoir maintained above the adjustment of the safety valve when the universal valve is in emergency or quick action position?

A.—Because the safety valve is cut off from the brake cylinder at this time.

338. Q.—How much brake pipe pressure will be required to accomplish a release with the L. N. equipment after an emergency application with the same standard 110 lbs. brake pipe pressure?

A.—About 107 lbs.

339. Q.—Why such a high pressure?

A.—Because in this position, the auxiliary and supplementary reservoir equalize with the brake cylinder at about 105 lbs. pressure if the brake cylinder piston travel is correct.

340. Q.—Is this high brake cylinder pressure retained to the point of stop?

A.—Yes; if the brake is not released.

341. Q.—What regulates the pressure in the brake cylinder during service operation?

A.—The safety valve of the L triple valve.

342. Q.—Why does it not regulate the brake cylinder pressure when the triple valve moves its full travel to emergency position?

A.—Because the slide valve cuts off the safety valve from the brake cylinder in this position.

343. Q.—In taking slack to start a train, should the engine be reversed with steam in the cylinders and the brake released?

A.—No.

344. Q.—Why not?

A.—On account of the liability of breaking the train in two.

345. Q.—How would the engine, especially if a superheater, be reversed when taking slack?

A.—With the independent brake applied.

346. Q.—How should it be released after the slack is taken?

A.—It should be graduated off.

347. Q.—How is a failure to observe this liable to cause a train to part?

A.—By having the two ends of the train moving in opposite directions at the same time.

348. Q.—Can this happen in passenger service?

A.—Yes; it frequently does.

349. Q.—What is the effect even if the train does not part?

A.—It causes a very heavy shock to the train.

350. Q.—Explain how the train happens to be moving in two different directions at the same time if the reversal is made too suddenly?

A.—The engine starts the train backward, and if quickly reversed and the head end started forward the rear cars may still be moving backward, which sometimes results in breaking-in-two of train.

351. Q.—When coupling an engine and several fully charged cars to a number of other cars that are not changed or only partially charged, what may be expected on the charged cars if the brake pipe angle cocks are opened suddenly?

A.—Quick action of the brakes on the charged cars.

352. Q.—What if they are coupled properly, and the air compressor and main reservoir capacity is sufficient to accomplish a prompt release of the brakes on the fully charged cars, will a brake application a few seconds afterward result of an application of all of the brakes in the train?

A.—No.

353. Q.—Which brakes will apply?

A.—Those on the cars that were fully charged when coupled.

354. Q.—Why will the others fail to apply?

A.—Because the auxiliary reservoirs have not had time to become charged equally with the other cars.

355. Q.—What would be the effect of having two fully charged cars next to the engine and several other cars at the rear that were not fully charged and a brake application was made going ahead?

A.—The brakes would not apply on the rear cars and there would be a run in from the rear.

356. Q.—If no one was watching the operation of the brakes on the train, what would the train crew likely assign as the cause of the shock?

A.—That the independent brake valve had been used to stop the train.

357. Q.—How could such a train best be stopped under such circumstances?

A.—With a very light application of the independent brake, or better still to wait until the reservoirs have become charged.

358. Q.—What is essential to a smooth stop with a passenger train?

A.—A uniform retarding effect from the various cars in the train.

359. Q.—Can this be obtained with unequal auxiliary reservoir pressures?

A.—No.

360. Q.—Can it be obtained with unequal auxiliary piston travel?

A.—No.

361. Q.—Can a train be stopped smoothly with a very high brake cylinder pressure?

A.—No.

362. Q.—Why not?

A.—Because the trucks will be stopped with the truck springs and draft springs heavily compressed, and as the car bodies then stop the action of the springs will again right them on the trucks, and the heavier the tension on the springs the quicker and more violent will be the return to normal state of equilibrium.

363. Q.—Why will this shock be more violent with high than with low brake cylinder pressure?

A.—Because the higher brake cylinder pressure will stop the trucks quicker than the low brake cylinder pressure, therefore create a greater tension on the truck springs and also the draft gear springs wherever differences in braking effect makes it possible to compress the draft springs.

364. Q.—What law governs this action?

A.—That action and reaction are equal in opposite directions, therefore the more force that is put into the springs during compression, the more that will be given back when the tension is suddenly relaxed.

365. Q.—Why is this not considered during emergency applications of the brake?

A.—It is, but an emergency application is intended to stop the train in the shortest possible distance, and smoothness of the stop is of secondary importance.

366. Q.—In handling passenger trains in yard shifting movements, where smoothness of the stop is the chief consideration, how much brake pipe reduction should be made for the initial reduction for a stop?

A.—It depends upon the length of the train and the type of brake equipments on the cars.

367. Q.—With ordinary trains of 10 or 12 cars, with type L or quick service type of triple valves?

A.—From 5 to 6 lbs.

368. Q.—How much with other types of triple valves?

A.—From 6 to 7 lbs. brake pipe reduction, depending upon their condition.

369. Q.—How much with universal valves or control valves?

A.—Seven to 8 lbs.

370. Q.—Why a heavier reduction with the universal and control valves?

A.—Because these valves are designed not to apply with less than a 5 or 6 lb. brake pipe reduction at any time.

371. Q.—Why is this?

A.—To prevent slight variations in brake pipe pressure from leakage and defective feed valves from causing a brake application when it is not desired.

372. Q.—When moving the brake valve from running position for an application where should it be moved to?

A.—Service application position.

(*To be Continued.*)

Car Brake Inspection.

(*Continued from page 125, April, 1918.*)

312. Q.—About what figure of brake cylinder pressure will be obtained as a result of an emergency application from 110 lbs. brake pipe pressure?

A.—From 85 to 88 lbs. with small brake equipments.

313. Q.—What figure with the large brake cylinders now used?

A.—There is practically no gain of any consequence obtained.

314. Q.—Where does the additional pressure obtained in emergency come from?

A.—From the brake pipe through the quick action valves of the triple valve.

315. Q.—Why is not the same proportion of increase obtained with the large brake cylinders?

A.—Because the volume contained in the brake pipe is not sufficient to produce any material gain.

316. Q.—Why is this brake pipe volume not increased in modern brake equipments?

A.—The brake pipe volume now to be handled is what may be termed excessive, and with modern brake equipments, a high emergency brake cylinder pressure is obtained by the addition of reservoirs, while the brake pipe pressure is exhausted to the atmosphere for the transmission of quick action, from one brake to the other.

317. Q.—What is the proper sized auxiliary reservoir for use with various sized brake cylinders?

A.—

Cylinder diam.	Reservoir.	Cu. in. capy.
10 inch........	12 x 27	2450
12 "	12 x 33	3088
14 "	14 x 33	4476
16 "	16 x 33	5724
18 "	16 x 42	7436

318. Q.—What is the total piston pressure developed by the various sized brake cylinders at 60 lbs. pressure per square inch?

A.—

Cylinder diameter.	Cu. in. capy.
10 inch..............................	4,700
12 "	6,700
14 "	9,200
16 "	12,050
18 "	15,500

319. Q.—What sizes of type P triple valves are used with these cylinders?

A.—P-1 for the 10-inch and P-2 for the larger sizes.

320 Q.—How do you find the capacity of one of these reservoirs?

A.—By multiplying the inside diameter by itself, and the product by the decimal .7854 and this sum multiplied by the inside length of the reservoir in inches gives the cubic-inch contents of the reservoir.

Q.—How do you find the contents of the brake cylinder?

A.—In the same manner, by multiplying the square of the diameter by the same decimal figure and the product by the length of the piston travel in inches.

322. Q.—What are the names of the levers attached to the brake cylinder?

A.—The piston lever and the cylinder lever.

323. Q.—What is a lever and what is it used for?

A.—A lever is a mechanical device hinged on a fixed point called a fulcrum and is used to increase and sometimes decrease the effect of a force applied to it.

324. Q.—How many classes of levers are used?

A.—Three.

325. Q.—How are they designated?

A.—As first, second and third class levers.

326. Q.—What class of lever is the floating lever?

A.—A third class lever.

327 Q.—Why?

A.—Because the force is applied between the weight to be lifted and the fulcrum.

328. Q.—What class of levers are live truck levers?

A.—Usually levers of the second class.

329. Q.—What are the cylinder and piston levers?

A.—First class levers.

330. Q.—Where is the fulcrum point on a first class lever?

A.—Between the points at which force is applied and where the weight is lifted.

331. Q.—Where is the fulcrum point of a second class lever?

A.—At the opposite end of the lever from which the force is applied.

332. Q.—How are the levers then distinguished?

A.—By noting the point of fulcrum and the point at which the force is applied.

333. Q.—Is the calculation of braking forces a difficult problem?

A.—If one rule is remembered it is a very simple matter.

334. Q.—What is this?

A.—To find the force delivered by a lever, multiply the force in pounds delivered by the distance in inches from the point where the force is applied to the fulcrum and divide this sum by the distance in inches between the fulcrum and the point at which the force is delivered.

335. Q.—Does this apply to any particular class of lever?

A.—No: all that is necessary is to distinguish the fulcrum and the force applied points.

336. Q.—What is meant by the term leverage?

A.—In car braking it means a combination of levers, through which the force developed by the brake cylinder is multiplied and transmitted to the brake shoes to become effective on the wheels.

337. Q.—In these calculations, how are the distances on levers measured?

A.—From the centers of the pin holes.

338. Q.—What is meant by the proportion of a lever?

A.—The ability of a lever to develop a certain force, in proportion to the force applied to it.

339. Q.—How is this proportion found?

A.—By dividing the force applied end by the force delivered end.

340. Q.—How is this division made on a second class lever?

A.—By dividing the total length of the lever by the short end.

341. Q.—How is the proportion of a first class lever found?

A.—By dividing the long end of the lever by the short end.

342. Q.—What is the name of the truck lever to which the force from the pull rod is applied?

A.—The live truck lever.

343. Q.—What is the name of the other upright lever?

A.—The dead lever.

344. Q.—Which is the cylinder lever?

A.—The one which connects with the slack adjuster or pressure head of the brake cylinder.

345. Q.—What is the name of the lever at the opposite end of the cylinder?

A.—The piston lever.

346. Q.—What is the duty of a brake cylinder?

A.—To utilize the power of the compressed air and transmit it through the foundation brake gear to the brake shoes.

347. Q.—If a brake cylinder develops a piston force of say 5,000 lbs., what will be the force delivered at the other end of the lever if the distances between force applied and force delivered points and the fulcrum are equal?

A.—5,000 lbs.

348. Q.—What will be the force developed if the distance from the piston lever connection to the fulcrum is 24 ins. and the distance from the fulcrum to the force delivered points in 12 ins.?

A.—10,000 lbs.

349. Q.—Why will the force in the latter case be doubled?

A.—Because the distance through which the force acts before reaching the fulcrum point is doubled.

350. Q.—In this case, if the force delivered and travels say 4 ins., during a brake operation, how far must the piston lever end travel?

A.—Double the distance or 8 ins.

351. Q.—Is there any limit to the number of times the cylinder value should be multiplied through the leverage system in a brake gear?

A.—Yes.

352. Q.—What is this limit?

A.—It should not be multiplied over 9 times.

353 Q.—What is this multiplication of the cylinder force termed?

A.—Total leverage.

(*To be continued.*)

Electrical Department

The Lightning Arrester—Electric Surges—Transfer of Weight Between Driving Wheels

With the advent of spring and summer, with the accompaniment of clouds and rainstorms, or lightning which is a great source of annoyance and trouble to the electrical operating man will be upon him. Lightning can cause a great deal of damage to electrical machinery, and it is absolutely necessary to provide protection against such damage.

Atmospheric lightning is due to discharges of electricity between two oppositely charged clouds, or between a cloud and the earth. These two charged bodies gradually become more heavily charged until the pressure, which runs into millions of volts, gets to a point where the atmosphere is broken down and the two bodies neutralize each other by the passage of lightning or current which surges between them. This lightning-discharge is not one discharge so to speak, but a series of oscillations of electric current. For instance, assuming a discharge between the cloud and the earth, the current will first pass from the cloud to the earth. A larger amount passes than is necessary to neutralize each, thereby bringing the earth to a higher potential than the cloud, and causing a surging back to the cloud again. This process is repeated many, many times in a very short space of time, and continues until the surges die out and the charge becomes neutralized. It is somewhat similar to the swinging of a pendulum which sways back and forth and finally comes to rest. The speed of the electric discharge is very high, so that many surges take place in the fraction of a second. Lightning from the standpoint of the electrical man is a term used to cover all kinds of disturbances in electrical transmission systems that take the form of high voltage. There are, really, two kinds of lightning—the atmospheric lightning mentioned above and the high voltage surges which are due to internal disturbances in the line itself. Lightning arresters are designed to obviate the destructive effects of both of these conditions.

The lightning arrester in dealing with atmospheric lightning discharges does not handle the direct lightning strokes. When a discharge from a cloud strikes an electrical conductor directly, it almost always breaks down the installation at or very near that point. It rarely travels along the wires far enough to reach the place where an arrester may be located, and even if it did, it would probably destroy any type of arrester, except possibly an electrolytic one, which will be described in detail later.

The difficulties with lightning are not due so much to the actual direct strokes on the line as they are to the disturbances which are induced on account of the lightning discharges taking place in close proximity to the transmission lines. The frequency of a lightning discharge is very high, amounting to hundreds of thousands of cycles per second, and this high frequency may build up a very high voltage in the windings of electrical machinery or transformers, resulting in a breakdown. The voltage of the induced disturbances varies all the way from very high values where the lightning occurs close to the line, down to a very small value where the lightning is a great distance away. A surge, therefore, induced by the lightning may cause damage either because of its high voltage which breaks down or punctures the insulation to the ground, or because of its high frequency. While the energy due to the surge is almost always small, still the voltage is sufficient to break down the insulation, and consequently the power current has then a chance to follow through, causing great damage.

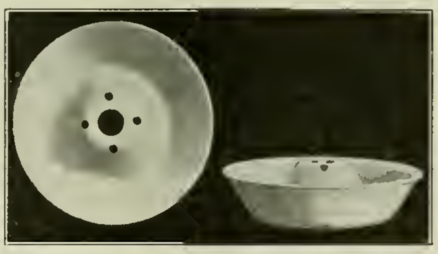


FIG. 1. ALUMINUM TRAYS FOR ELECTROLYTIC ARRESTER.

Internal lightning, or internal surges, may be caused by changes in the load. If a circuit-breaker is opened suddenly, or there is a momentary ground in one part of the system, a sudden high voltage surge may be set up which will pass over the system, and unless eliminated by a lightning arrester, will cause damage to the electrical machinery. This surging is somewhat analogous to the hammer in a water pipe. We are all more or less familiar with the fact that if running water is suddenly stopped a considerable blow may result throughout the piping.

There are several types of lightning arresters, but the most important, and the one which is now used extensively in power-circuits is the electrolytic lightning arrester. There are two essential properties inherent in this type of arrester, and it is due to these important properties that it operates so successfully. They are as follows:

(1) It offers a very high resistance to the flow of current at normal voltages and a very low resistance to current at abnormal voltages.

(2) Its effective resistance to currents at the normal frequencies is great, but to currents at high or abnormal frequencies it is small.

We have mentioned above, that lightning troubles were due to the high frequencies and also to the high voltages, so that here is a piece of apparatus which will take care of either of these abnormal conditions. The lightning arrester is connected to each of the transmission lines coming into a sub-station or power house, and in large systems arresters are connected to each of the transmission lines at frequent intervals along the right-of-way. This type of arrester is ideal, because it possesses characteristics analogous to those of a steam safety valve or an hydraulic relief valve. Such an appliance permits no escape of steam or water at normal pressures, but when the pressure exceeds the normal, the valve opens and the excess is relieved. Thus, with the electrolytic lightning arrester, while it is connected between the line and the ground, none of the power-current passes through it, but when abnormal voltage surges or high frequency oscillations are set up, due to atmospheric lightning discharges or to internal surges, they are dissipated through the arrester. When the excessive stress is relieved, the action of the arrester immediately prevents further flow of current.

The electrolytic lightning arrester consists of a system of nested aluminum cup-shaped trays (supported on porcelain and secured in frames of treated wood) arranged in a steel tank. The system of trays is electrically connected between line and ground and between line and line. The shape of the trays is shown in Fig. 1 and the assembly in Fig. 2. A cross-section of the complete arrester is shown in Fig. 3. A certain amount of electrolyte is placed in each tray and, due to the shape, the liquid comes in contact with the bottom of the tray immediately above. Every tray is filled, so that there is a complete connection throughout the whole series of trays. Transformer oil is then poured into the tank. The electrolyte is heavier than oil and therefore remains in the bottom of the trays. The oil serves four purposes, viz.: (1) It improves the insulation between the trays. (2) It increases the insulation between the tanks and the trays in all cases where insulation is necessary. (3) It prevents evaporation of the electrolyte. (4) It helps to dispose of the

heat caused by lightning discharges by: Absorbing some of the heat, and carrying the heat to the steel surface of the tank, whence it can be radiated, thus permitting the arrester to discharge continuously for relatively long periods without becoming overheated.

When the power is connected to the arrester after the latter has been assembled, current flows from tray to tray through the electrolyte. The passing of this current through the liquid acts on the liquid and there is formed on each aluminum tray a film. This film, although very thin, has an exceedingly high apparent resistance when moderate voltages are impressed on it, but when the pressure reaches a higher well-established value, known as the critical voltage, the film breaks down in myriads of minute punctures. The critical voltage varies with various electrolytes, but it is approximately 390 volts for alternating current and 440 volts for direct current. Voltages above the critical point are very nearly short-circuited, and the flow of current is retarded only by the resistance of the electrolyte. The discharge current is permitted to pass with a freedom proportional to the superficial area of the aluminum plate surface exposed to the electrolyte. When the excessive pressure is relieved and normal pressure restored, the minute punctures at once seal up; the original resistance reasserts itself, and no discharge of dyanmic power follows. The

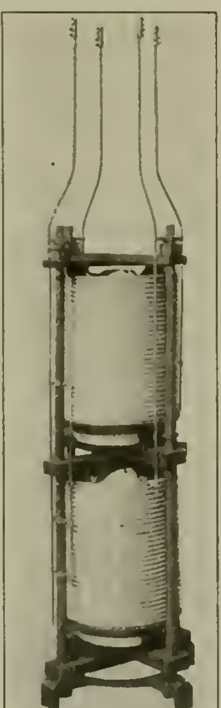


FIG. 2. ASSEMBLY OF TRAYS IN WOODEN FRAME.

films on the surfaces of the trays gradually dissolve and require periodical "charging" to keep the arrester in operating condition. Daily charging is recommended as the best practice, but longer periods are practicable, depending on the condition of arresters and the surrounding temperature. Charging is accomplished by bridging the horn gaps for a few moments; this impresses line voltage on the arrester and rebuilds the films. The horn gaps are placed in the connection between the line and the arrester; normally they insulate the arrester from the line, but at excess voltage they arc over and permit a discharge through the arrester.

There is a tendency on the part of the films on the aluminum trays to disintegrate when the trays are allowed to remain indefinitely with no voltage connected across them. If an electrolytic arrester has stood for some time without being connected to the circuit, there will be a sudden rush of current through the arrester, and it may be necessary to reduce the voltage to prevent an excessive current. If the arrester is connected daily to the line, the film is maintained in good condition, and the rush of current will be harmless in magnitude.

There is a tendency for the films on the trays to disintegrate more rapidly when the electrolyte is at a high temperature, and therefore it is necessary to charge more often in warm weather than in cold weather. The arrester is charged by short circuiting the horn gaps for a period of five seconds. This may be repeated two or three times, as the passage of the power-current builds up the film.

The condition of the arrester is indicated by the arc which exists when the horn gaps are bridged. If a heavy, fluffy, reddish arc is maintained which rises high on the horns, it shows that the arrester is in bad condition and the film has not formed. If all of the plates are not in contact through the medium of the electrolyte, or if the oil has run into the space between them, due to the fact that the trays were not properly filled with electrolyte, there will be very little spark if any, when the horn gaps are bridged. The normal condition of the arrester is indicated by a bluish, crackling spark, which tends to die out and which does not rise high on the horn gap.

An arrester should be watched and inspected at frequent intervals, and should be carefully examined at least once a year, just before the lightning season. It may be necessary to dismantle, clean the plate thoroughly, and refill the aluminum trays with electrolyte and oil.

Transfer of Weight Between Drivers.

At a recent meeting of the New York Railroad Club, Mr. F. H. Shepard, director of heavy traction for the Westinghouse Electric and Manufacturing Company, said, among other things, when speaking of the new Chicago, Milwaukee & St. Paul electric locomotives, that a natural question would be, What were the considerations which led to the selection of this type of locomotive, possessing, as it does, certain additional mechanical

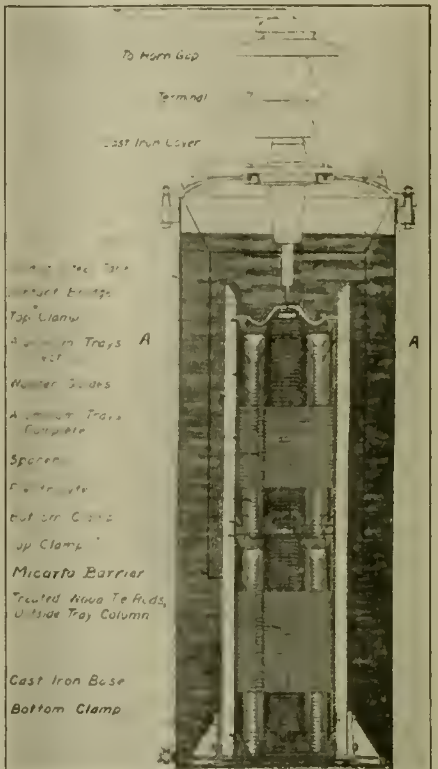


FIG. 3. SECTION OF TYPICAL ELECTROLYTIC ARRESTER.

complications as compared to certain other types? In the absence of determination from service which may be directly comparable, the reasons may be classed as somewhat theoretical. It was understood that the weight on the driving axles, both as to amount and disposition (on the present engines) would not be accepted for other engines for passenger service, so that a departure from the design of the locomotive at present in passenger service, was required. This could have been accomplished by the use of more driving wheels with smaller and lighter motors, or, again, by the use of very large motors with side rods. Service conditions require a minimum of six driving axles, with a weight of 55,000 lbs. on each. This can be very reasonably and economically met by twin motors with quill drive, and this construction possesses certain material advantages.

The utilization of the weight of the locomotives for adhesion is not of the same importance in passenger power as in locomotives for freight service. However, the relative value of wheel arrangement is effected by weight transfer, because the tractive effort is applied at the height of the draw bar, as shown in the diagram. In other words, the frame of the locomotive is tilted. Thus in our illustration, Fig. 1, it will be noted that

with 30 per cent adhesion, the weight transfer of this wheel arrangement is no more than 6 per cent, while if the wheel base was as short as 10 ft. 6 ins., Fig. 2, the weight transfer under the same condition would be 16.4 per cent. From this it can be seen that for drag or heavy freight service, the use of side rods has a distinct advantage, since all of the driving wheels on the truck are coupled.

American railroad track is a cushioned, yielding structure, but, unfortunately, the yield of the rail, due to wheel loads, is not uniform, and varies greatly, depending upon the track joints, and special work, conditions of ballast and grade. This general condition is augmented, of course, by the extreme weather conditions experienced in the country which the C. M. & St. P. road traverses.

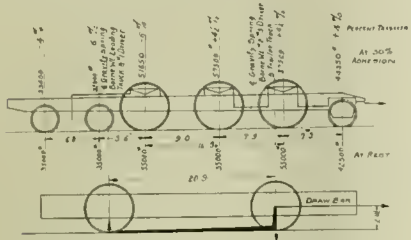


FIG. 1.

A great deal of importance has been placed upon such questions as center of gravity, wheel arrangement, size of wheels and equalization on steam locomotives, especially for passenger service. The steam locomotive, of necessity, consists of a large mass, including boiler and cylinders, carried on the locomotive frame, the driving wheels being loosely and flexibly connected thereto. Space limitations also require a relatively high center of gravity. It is a curious coincidence that this limitation in the design of steam locomotives automatically secures easy action upon the road bed. This is on account of the flexibility of the heavy parts of the locomotive, the individual axles being relatively free from restraint from directly imposed weight. In the electric engine here considered, these advantageous features are all retained. In the use of side rods on electric locomotives the action differs from that of steam locomotives, in the entire absence of dynamic augment, produced by the lack of counterbalance of the reciprocating parts of the steam locomotive for all speeds. The electric locomotive with side rods is perfectly counterbalanced for all speeds, since the motion of the rods is of pure rotation only.

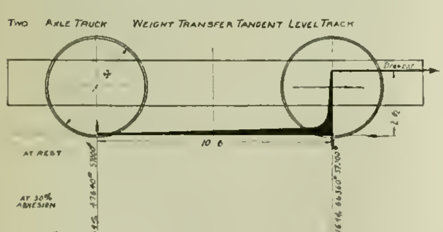


FIG. 2.

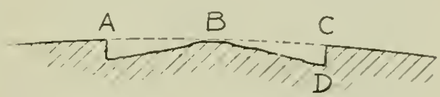
In calculations involving adhesive weight we have generally taken the accepted figure .25 and this has been all right. Electrical engineers say that this figure is very frequently too low, and that with a clean, dry, rail, perhaps automatically sanded slightly by the wind blowing grit in on it that the adhesion ought to be higher, say at about .30. If this is true, the electric engine makes even better use of it, than the steam locomotive does, with its reciprocating motion, where the connecting rods exert maximum pressure at one part of the stroke and zero at another. The steam locomotive may almost proceed over the track by a series of bounds, and if badly counterbalanced for a certain speed, it may even periodically leap into the air. This will never be visible to the naked eye, but experiment may show that such a condition exists in fact. The electric locomotive, having a constant torque, and counterbalanced to a nicety, does not tend to bound, but progresses steadily and evenly along the track without dynamic augment. If adhesion is higher than .25, the electric locomotive makes the very best of the advantage caused by the circumstance.

The "Shelled-Out" Spot.

It often happens in a long, heavy train that certain cars are called upon to do from 100 to 300 per cent more work in the matter of retardation than other cars of the same capacity, and inasmuch as this excessive retardation is transforming mechanical energy into heat the final result must show itself on the tread of the wheel. This has been called, when it is formed, a shelled-out spot, and it was originally considered to be an initial defect in the wheel for which the maker of the wheel was held to be responsible, and he was accordingly charged with the resultant cost of the change. This is really an error, as brake action appears to be entirely responsible for the defect. Our illustration shows a cross section of a shelled-out spot. That portion between A and C during the process of skidding is at an extremely high temperature practically at the melting point, and expansion is restricted by the shoulders A and C of cold metal, and as the hottest portion of the metal is at the center B, it expands upward, allowing the concentric rings of metal to expand toward the center, causing a cleavage plane along the line B-D. After the skidding ceases, the metal is very quickly cooled, which causes thermal cracks to be introduced in concentric rings and the subsequent pounding on the rail disintegrates the metal which, after falling out, gives us the familiar shelled-out spot.

Where the wheel slides for a greater distance, the melting point is reached and a segment of the metal is rapidly rubbed away which quickly increases the area of contact, giving a much larger surface to receive the heat, thereby reducing the temperature. In this case the heat is sufficient to cause disintegration of the metal from a net work of fine thermal cracks which, as in the case of the shelled-out spot disintegrates and drops out from the surface of the tread of the wheel in subsequent service, leaving a rough and jagged appearance.

This latter defect is commonly termed "comby from slid burn." If the sliding had continued over a much longer distance a typical flat spot would have resulted, which would necessitate the removal of the wheel. It was formerly the custom to call these defects "sand holes" or "slag in the metal," indicating an initial defect in the wheel. This idea, however, is not consistent with observations in practice, where it is usual to find such defects in both wheels of a pair, indicating that the defect arose from the slipping of the wheel on the rail. The tendency of wheels to shell in pairs or in several pairs under the same car is well illustrated in an analysis of results obtained from 500 refrigerator cars, representing a total of 4,000 wheels. Of this number, 189 were removed for shelling-out, and the relation of this defect to the mate wheel on the same axle, is shown by the summary: 174 shelled in pairs, 15 shelled singly.



CROSS SECTION OF SHELLED-OUT SPOT.

This indicates not only that shelling-out is due to intense local heating while the wheel is skidding on the rail, but it is also a matter of observation that this defect occurs under equipment having the highest braking power and making most frequent stops, such as tender wheels, heavy passenger and interurban carwheels, and in freight service it is much more common in the cars of heavy tare which, in some cases, have a braking power 10 per cent above the M. C. B. standard.

The Colors of Nature.

Nothing in nature is actually the color we see it. It only appears to us at a given moment as a particular color in relation to other apparent colors, which surround it. Thus we may walk out on a rainy evening, when the sky and everything is grey, and come indoors and light the lamp, and immediately the sky which we see through our windows appears as a beautiful and tender blue, though there was no trace of blue in the sky a minute before, when we were outside. The change is produced in our senses by the color of the sky taking its place in relation to a range of warm colors in the lighted room.

Items of Personal Interest

Mr. B. W. Goggins has been appointed roundhouse foreman of the Chicago, Milwaukee & St. Paul, with office at Lewiston, Mont.

Mr. W. F. Wright has been appointed assistant purchasing agent of the Louisiana & Arkansas, with office at Texarkana, Ark.

Mr. A. J. Beuter, formerly representative of the Baldwin Locomotive Works at San Francisco, Cal., has been transferred to Portland, Ore.

Mr. W. B. Stokes has been appointed master mechanic of the Wrightsville & Tennille, with office at Tennille, Ga., succeeding Mr. M. G. Brown.

Mr. Thomas Spratt, assistant purchasing agent of the Norfolk & Western, with office at Roanoke, Va., will assume the duties of purchasing agent.

Mr. K. S. Stephens, formerly assistant storekeeper of the Atchison, Topeka & Santa Fe, with office at Temple, Tex., has been appointed storekeeper at Galveston, Tex.

Mr. W. D. Hartley, formerly division foreman of the Santa Fe at Barstow, Cal., has been appointed general foreman at Richmond, Cal., succeeding Mr. C. Raitt, promoted.

Mr. T. Devaney, formerly general foreman of the locomotive repair shop of the Toledo, St. Louis & Western, has been appointed master mechanic, with office at Frankfort, Ind.

Mr. W. F. Lamb has been appointed division storekeeper of the Southern railway, with headquarters at South Richmond, Va., succeeding Mr. J. E. Angel, promoted.

Mr. W. R. Gilpin, formerly road foreman of engines on the Union Pacific, with office at Evanston, Wyo., has been appointed general air brake inspector with headquarters at Omaha, Neb.

Col. Henry B. Pope has resigned his position as vice-president and general manager of sales of the Carnegie Steel Company, and Mr. William G. Clyde has succeeded to the position.

Mr. T. W. McBeath, formerly traveling foreman of the Canadian Government railways, with office at Moncton, N. B., has been appointed master mechanic, with office at Moncton.

Mr. J. W. Reynolds has been appointed blacksmith foreman of the Southern Pacific, with office at Tucson, Ariz., succeeding Mr. J. G. Ayers, promoted to a similar position at Portland, Ore.

Mr. Thomas B. Dickerson has been appointed acting superintendent of shops of the Central Railroad of New Jersey with office at Elizabethport, N. J., succeeding Mr. G. L. Von Dorn, resigned.

Mr. C. O. Davenport, formerly road foreman of engines of the Chicago, Burlington & Quincy, with office at Alliance, Neb., has been appointed master mechanic, with office at Sterling, Colo.

Mr. W. H. Winterrowd, formerly assistant chief mechanical engineer of the Canadian Pacific, has been made chief mechanical engineer, with office at Montreal, Que., succeeding Mr. W. F. Woodhouse.

Mr. E. E. Ramey, formerly supervisor of trains of the Baltimore & Ohio, with headquarters at Philadelphia, Pa., has been appointed supervisor of fuel consumption, succeeding Mr. W. L. Robinson, resigned.

Mr. G. H. Robinson, general storekeeper of the Oregon Short Line, with office at Pocatello, Ida., has been appointed acting purchasing agent in addition to his duties as general storekeeper, with headquarters at Salt Lake City, Utah.

Mr. Charles P. Angell, formerly train master of the New Castle division of the Baltimore & Ohio, has been appointed assistant superintendent in charge of terminals of the Pittsburgh division, with headquarters at Pittsburgh, Pa.

Mr. M. J. Powers, formerly master mechanic of the Denver & Rio Grande, Colorado lines, with office at Denver, Col., has been appointed superintendent of motive power of the Colorado Midland, with office at Colorado Springs, Colo.

Mr. H. Eisle, formerly general foreman of the Wabash shops at Decatur, Ill., has been appointed shop superintendent, and Mr. T. Tracy has been appointed foreman of the machine shop, succeeding Mr. E. J. Wansbach, appointed general foreman.

Mr. E. C. Anderson, formerly mechanical engineer of the Colorado & Southern, with headquarters at Denver, Colo., has been appointed assistant mechanical engineer of the Chicago, Burlington & Quincy, with office at Chicago, Ill.

Mr. George A. Kirley, formerly assistant signal engineer of the Boston & Albany, has been appointed signal engineer, with headquarters at Boston, Mass., and Mr. E. I. Gardiner, formerly draftsman in the signal department, succeeds Mr. Kirley.

Mr. H. D. Savage has been elected vice-president of the Locomotive Pulverized Fuel Company. He will also continue as vice-president of the American Arch Company. Mr. Savage has had a wide experience in the application of refractories to the metallurgical field.

Mr. Godfrey Lamberg has been appointed general foreman of the Chicago, Milwaukee & St. Paul, with office at Minneapolis, Minn., and Mr. John H. Houck has been appointed shop foreman, and Mr. Herman F. Belitz has been appointed roundhouse foreman, at Minneapolis.

Mr. H. P. Anderson, formerly mechanical engineer of the Missouri, Kansas & Texas, has been appointed superintendent of motive power, with headquarters at Denison, Tex., succeeding Mr. F. W. Taylor, who has been promoted to be general manager, with headquarters at Parsons, Kan.

Mr. F. W. Schultz, master mechanic of the Kansas City, Mexico & Orient of Texas, with office at San Angelo, Tex., has also been assigned to the duties of superintendent of motive power and car departments of the same road, the latter office having been abolished. In addition to headquarters at San Angelo, Mr. Schultz will also have offices at Wichita, Kans.

Mr. F. W. Taylor, formerly superintendent of motive power of the Missouri Kansas & Texas, with headquarters at Denison, Tex., has been appointed general manager, with headquarters at Parsons, Kan., succeeding Mr. H. Anderson, who has been transferred to San Antonio, Tex., as superintendent of terminals of the Missouri, Kansas & Texas of Texas.

Mr. W. L. Robinson, formerly supervisor of fuel consumption of the Baltimore & Ohio, has accepted a position in the operating department of the E. I. du Pont de Nemours Company, Wilmington, Del. Mr. Robinson is vice-president of the International Railway Fuel Association and the Smoke Prevention Association, and is a recognized authority in railway fuel matters.

Mr. A. L. Roberts, formerly mechanical engineer of the Lehigh Valley, has been appointed master mechanic, with office at Wilkesbarre, Pa., and Mr. J. P. Laux, formerly master mechanic, with office at Sayre, Pa., has been transferred to South Easton, Pa., and Mr. E. J. Kleinkauf, formerly general foreman at South Easton, has been appointed master mechanic at Sayre, succeeding Mr. Laux.

Mr. H. S. Wall, formerly superintendent of shops of the Atchison, Topeka & Santa Fe Coast Lines, at San Bernardino, Cal., has been appointed mechanical superintendent, and Mr. A. B. Armstrong, formerly master machanic at San Bernardino, has been appointed superintendent of shops, succeeding Mr. Wall, and Mr. John Pullar, formerly master mechanic at Fresno, Cal., has been transferred to the Los Angeles division, with office at San Bernardino, succeeding Mr. Armstrong.

Mr. J. C. Rockwell has been promoted from manager of the light and power department to general manager of the Manila, P. I., Electric Railroad & Light

Company. Mr. Rockwell was graduated in 1904 from Cornell University with the degree of mechanical engineer. Following his graduation he engaged in track construction work. In 1906 he became superintendent of transportation of the Syracuse, N. Y., Lakeshore & Northern Railroad Company. He was appointed general superintendent in 1909 of the Charleston, W. Va., Interurban Railroad Company, and the following year was elected general manager of this company. In 1911 he joined the operating organization of the J. G. White Management Corporation, New York City, and was assigned to the Manila Electric Railroad & Light Company as manager of the light and power department. Mr. Rockwell has been on a visit to the United States and is now returning to Manila.

Mr. W. S. Bartholomew, president of the Locomotive Stoker Company, has been elected vice-president of the Westinghouse Air Brake Company, with charge of the activities of the Stoker company and such other duties as may be assigned to him. Mr. Bartholomew is a graduate of the North-Western University. After serving as eastern manager for the firm of Adams & Eastlake, he entered the service of the Westinghouse Air Brake Company in 1903 as New England representative at Boston, Mass. In 1905 he was appointed western representative, with headquarters at Chicago, Ill. In 1913 he was elected president of the Locomotive Stoker Company, and has been particularly active in the development of the Street stoker, and its installation on

W. S. BARTHOLOMEW.

locomotives throughout the country. Mr. Bartholomew still retains his office as president of the Locomotive Stoker Company, in addition to his new appointment as noted above.

Mr. George W. Wildin has resigned as general manager of the New York, New Haven & Hartford to accept an appointment in the employ of the Westinghouse Air Brake Company as general manager

GEORGE W. WILDIN.

of the Locomotive Stoker Company, with headquarters at Pittsburgh, Pa. Mr Wildin is a graduate of the Kansas State Agricultural College with the degree of Bachelor of Science, and entered railway service on the Santa Fe in 1892. As machinist, fireman, engineman, car inspector, and mechanical engineer, he had a wide experience on some of the leading railways in the West. In 1901 he was appointed mechanical engineer for the Central Railroad of New Jersey. In 1904 he was appointed assistant mechanical superintendent of the Erie, and in the same year promoted to mechanical superintendent at Meadville, Pa. In 1907 he served as assistant superintendent of motive power of the Lehigh Valley, and in the same year accepted the position of mechanical superintendent of the New Haven, and in 1917 he was advanced to general mechanical superintendent, and in the same year was again promoted to the position of general manager as noted above. Mr. Wildin is a member of many of the leading engineering societies or clubs, and in 1910 was president of the American Railway Master Mechanics' Association.

Mr. W. S. Murrian, S. M. P. & E. on the lines East and West of the Southern Railway, with headquarters at Knoxville, has tendered his resignation, to accept another position. He learned the trade of machinist on the U. P. and worked in that capacity for several years, having been promoted from time to time to the various positions that are available in railroad circles. Mr. Murrian is personally interested in the specialties now being manufactured by the Southern Locomotive Valve Gear Company, and he is also thoroughly familiar with the effieciency of the commodities.

Many of the leading business men in Knoxville are connected with the Valve Gear Co. and General L. D. Tyson, now in active service in the United States Army, had been president since the organization of the company. In tendering his resignation, he made the recommendation that Mr. Murrian be requested to accept the presidency of this concern, and take up the active management of the Gear company's affairs. Mr. Murrian accepted the position leaving the service of the Southern Railway.

Mr. George A. Post has recently resigned the Presidency of the Railway Business Association. Mr. Post was educated in the academy and normal school at Oswego, New York. He entered railroad work in the freight department of the Erie Railroad Company in 1872. later he became assistant to the superintendent of motive power on that road. During this time he studied law at night and was finally admitted to the bar of Pennsylvania. Later he became vice-president of the Standard Coupler Company and was subsequently elected to the presidency of that company. He was elected to the forty-eighth Congress. He was the youngest member of Congress at the time of his election and was then an active temperance stump speaker. He acquired much parliamentary experience owing to his connection with a number of fraternal societies and his intimate relation with politics. After becoming a manufacturer, he was an influential figure

GEORGE A. POST.

in the activities of the Railway Supply Manufacturers' Association in connection with the American Railway Master Mechanics' Association and the Master Car Builders' Association. In 1908 Mr. Post

proposed and with the assistance of Mr. C. A. Moore, Mr. J. S. Coffin and Mr. Otis H. Cutler convoked a meeting which resulted in the formation of the Railway Business Association. This association had the effect of bringing together men engaged in the production of widely diverse articles but the common aim of all was to help of the purchasing power of the railways, to which all these gentlemen sold more or less of their output. Mr. Post during the nine and a half years of service as president of the Railway Business Association has become widely known as a speaker and leader of public thought on various transportation questions. His resignation from the presidency of the association will not diminish his interest in the welfare of the organization but will enable him to devote more time to the prosecution of his own business.

Thomas P. Kenney

The service flag with one blue star that hangs in the office of Railway and Locomotive Engineering records the fact that one of our staff is with Uncle Sam's forces in the war in which America has resolved to beat down this hideous German thing. The star stands for Thomas Patrick Kenney, a sturdy young man of 24 years, who was one of the juniors in our office, and a brother of our esteemed general manager. He was educated at St. James' Academy, Brooklyn, N. Y., from which he graduated in 1914. Young Kenney was prominent in athletics, and thus not only strengthened his physique but imbibed the manly qualities so many athletic men exhibit, which is to fight

THOMAS P. KENNEY.

clean, and take and give hard knocks without losing his temper, or being occasioned unnecessary fright or thrown into panic—the very type of soldier to do credit to his own family and friends and be an honor and an enduring help to the noble cause for which his country stands pledged.

Mr. Kenney, after graduation, was employed in munition work, where he learned what could be learned in the time, of munition making, and many facts connected with mechanical drawing and engineering. He came later to the Angus Sinclair Company, where the science of engineering is the subject at which all work. He remained with us two years, until the call to the colors was sounded throughout the land. He is now awaiting active service with the first Replacement Regiment of Engineers.

Tom Kenney is the type of man to make what newspapermen call "effectives," and he has the requisite qualifications in high degree. Civil life has surrendered its best to the army at the imperative call of duty, and his family have the satisfaction of knowing that they have "done their bit," without counting the cost, in the service of the land they love. No one can do more, and while the office has lost the services of a zealous, conscientious and willing employee, it must inevitably stand aside in apportioning the honor to his family and his country, but it may boast that the man who has joined the khaki columns of America and the Allies as they blend into one clay-colored host fighting for the right, it has given the best it has seen or known.

OBITUARY.

Alexander Fraser Sinclair.

We regret to announce that our Glasgow correspondent, Alexander Sinclair, died on March 10, after a brief illness. Alexander was the youngest of four sons of Alexander Sinclair and Margaret McLeay. Angus, our chief, being the eldest, is now the only remaining member of the family.

The father of the Sinclair family was Highland-born and, like many others, moved to the Lowlands when railway construction began and he continued in that occupation during his whole working life. The sons naturally followed that employment and Alexander began his first work on the Oban Railway. After engaging in other lines of work for a few years, he entered His Majesty's Customs, where he remained until he reached the age limit and was superannuated. He always had an inclination towards journalism, and for many years he wrote for the *Automobile Magazine*. When that publication went out of the hands of the Angus Sinclair Co., Alexander connected himself with Railway and Locomotive Engineering, a position he held at the time of his death. For many years he was also a contributing editor on the staff of the Glasgow *Herald*, and conducted the engineering and automobile department in that popular Scottish newspaper. On the outbreak of the war he was called into the Government service, testing motors for the war department.

The four Sinclair sons all made their way in the world very successfully. On his last visit to the family residence, Angus answered a ring at the door bell,

ALEXANDER F. SINCLAIR.

and the gentleman who called said he was looking for Mrs. Sinclair who had the four braw sons. That was the standing she had in the village. The standing of Angus, the eldest, is well known to our readers. Donald, the second son, became a railroad contractor and finished his labors by constructing a large part of the drainage canal at Chicago; the third brother, William, became a doctor, and was knighted by King Edward VII, owing to his high professional services.

Sir Collingwood Schreiber.

A remarkable figure in railway engineering has passed away in the death of Sir Collingwood Schreiber. For sixty years he had been actively associated in the construction and development of the railways in Canada. As deputy minister of railways he wisely administered the line directly under the government, and superintended the construction of the Grand Trunk Pacific. He was in the earlier days of its establishment chief engineer of the Canadian Pacific, and latterly chief engineer of the western division of the National Transcontinental Railway. He was born in Essex, England, in 1831, and came to Canada in 1852 and began his railroad career on the engineering staff of the Toronto and Hamilton Railway. In 1860 he superintended the construction of the Northern Railway, and from that date until a few years ago he seemed to be connected with the engineering department of nearly every railroad in Canada. He was a typical pioneer, of great physical strength and at the age of 79 he continued his inspection tours from road to

road a horseback. He died at Ottawa last month after a brief illness.

It is needless to say that he was the chief consulting engineer of the Dominion government and there was hardly an engineering or scientific society in Canada that did not look for his name to be on their list of prominent members. He was recognized by the Imperial authorities by having the honor of knighthood conferred upon him in consequence of his distinguished services and unique position as an engineer. The letters which follow his name, K. C. M. G. refer to his being made in 1916 a knight commander of St. Michael and St. George, an order of knighthood which is honored throughout the British empire and on its list of members are many colonial men of prominence and high merit.

Joseph W. Taylor.

Mr. Joseph W. Taylor, secretary of the Master Car Builders' and the Master Mechanics' Associations, died at his home in Chicago, Ill., in April 24. Mr. Taylor entered railroad service in 1876 as clerk in the freight office at Lottsburg on the West Pennsylvania division of the Pennsylvania Railroad. In July, 1880, he entered the office of Mr. F. M. Wilder, superintendent of motive power of the New York, Lake Erie & Western Railway, and served in various capacities under Mr. Wilder and under the latter's successor, Mr. R. H. Soule. In 1887 Mr. Taylor was appointed chief clerk in the office of Mr. R. H. Soule who was then general manager of the New York, Lake Erie & Western. On Mr. Soule's resignation Mr. Taylor accepted a position in the office of Mr. S. M. Felton, first vice-president of the same road. He was later secretary to Mr. A. Hegewisch, president of the United States Rolling Stock Company at New York City. Mr. Taylor resigned to accept the position of secretary of the Chicago & Calumet Terminal Railway Company. In 1891 he took service with Mr. John W. Cloud, the western representative of the Westinghouse Air Brake Company, and secretary of the Master Car Builders' Association, and later also secretary of the Master Mechanics' Association. Mr. Taylor remained continuously in this service until his election to the secretaryship of the two associations on Mr. Cloud's resignation to go abroad in 1899. Mr. Taylor was thus eminently qualified both by education and experience for the duties of the offices which he has filled ever since with marked ability. He was a fluent and ready speaker, and of an engaging personality, and his thorough knowledge of the intricacies of the offices that he held and his knowledge of correct parliamentary procedure made him of service at the societies meeting. He was greatly appreciated and liked by the members among whom he was held in the highest esteen.

JOSEPH W. TAYLOR.

Rufus F. Emery.

Mr. Rufus Franklin Emery, secretary and treasurer of the Westinghouse Air Brake Company, died April 11, 1918. Mr. Emery was born in 1869 at Chatham, Mass., where he spent the major part of his early life. He was educated in the grammar and high schools of Chatham, graduating with honors. He entered business life early. After service with several business interests in the Pittsburgh district, he entered the employ of the Westinghouse Air Brake Company in September, 1892, where he held various positions of trust and responsibility, finally being elected secretary and treasurer in 1909. At the time of his death, Mr. Emery was an officer and director in a number of prominent business and financial institutions in the Pittsburgh district.

RUFUS F. EMERY.

Air Brake Association.

The twenty-fifth annual Convention of the Air Brake Association will be held at Cleveland, Ohio, beginning on Wednesday, May 7, and continuing the remainder of the week. The officers are as follows: President C. H. Weaver, L. S. & M. S. Ry.; first vice president C. W. Martin, P. R. R.; second vice president, F. J. Barry, N. Y., O. & W. Ry.; third vice president, T. F. Lyons, L. S. & M. S. Ry. Secretary F. M. Nellis, Westinghouse Air Brake Company.

Triennial Convention, B. of L. E.

The second triennial convention, being also the 55th anniversary of the establishment of the order, will be held in Cleveland, Ohio beginning on Wednesday, May 7, in the Auditorium built for the express purpose of accommodating the delegates when they assemble to represent the 75,000 members. The loyalty of the Brotherhood in the present national crisis is beyond question, and it is expected that steps will be taken to emphasize the views of the Brotherhood in the unanimity of action in sustaining the government in the new relationship which has been established.

Machinery Convention.

The enormous problem of manufacturing and supplying machinery and tools sufficient for the carrying out of the government program for the production of ships, shells, guns and aircraft will be the subject considered at the great "War Convention" of the machinery, tool and supply industry of the country, to be held in Cleveland the week of May 13.

One thousand men who are bearing the brunt of the unprecedented demand for machinery will gather from all parts of the country to lay out a plan, with the aid of government officials, to keep the great munition program going at top speed. The big war convention will be a joint meeting of four great national associations, the American Supply and Machinery Manufacturers Association, the National Supply & Machinery Dealers Association, the Southern Supply & Machinery Dealers Association, and the National Pipe & Supplies Association, which will meet together in order to coordinate their efforts toward one common goal.

New York Railroad Club.

The regular monthly meting of the New York Railroad Club was held on Friday evening, April 19. Mr. R. L. Browne, Engineer of the Metal & Thermit Corporation, read an interesting paper on "Thermit Welding," giving a very interesting historical and scientific presentation of the subject with numerous lantern

slide illustrations. A large number of locomotive repair operations were shown, among which were welding in mud rings, the welding being made without cutting the sheets. The attendance was large, and the discussion brought out much valuable data.

Early Locomotive Engineers.

As early as 1839 a warm discussion arose among American railroad officials concerning the experience and skill necessary in the men assigned to the running of locomotives. A prominent official writing in *Colburn's Railroad Advocate* held that some of the men put in charge of that expensive machine, a locomotive, should not be entrusted to have charge of horses pulling a stage coach. A movement was started to establish instruction places for the training of firemen to make them efficient locomotive engineers.

The Man in the Cab.

"When you saw him last he was sitting quietly in his seat back of the big boiler, watching the crowd hurry down the platform to business and friends—a strong unromantic figure in oily overalls," says an editorial in "The World To-day." "Probably you did not give him a second glance, but a few moments since he had held your life and hundreds of other lives literally in his hand.

"Engine driving makes automobile driving mere play. If you are able to buy or borrow money enough to buy an automobile you may have the joy of facing death wherever you may choose and the policeman is not watching, but you are mercifully prevented from letting many others share your fate. The engineer has no such limitations. He is at the mercy of mankind, nature, and his time-card, but a train load of people is the stake for which he plays. Of himself he cannot think. Face to face with the inevitableness of the next moment, if disaster comes through another's carelessness he must be the first to suffer. If he himself errs, there is no one to share the blame. He is the incarnation of responsibility that can neither be shared nor shifted.

Priming in Locomotive.

Priming is water carried away with the steam from the boiler to the cylinders. It was found that in every case of priming investigated the cause was the foaming of the water in the boiler. Foaming is the phenomenon exhibited by some waters of producing a very large number of small bubbles when boiled. The bubbles occupy a large volume of the steam space, and in extreme cases take up the whole space previously occupied by the liquid as well, so that there is no liquid, as such, left. These bubbles are about one-sixth inch diameter. Both foaming and priming are highly dangerous; the foam may be so bad as to leave little liquid in the boiler, thus risking overheating and collapse of crown plate or tubes.

Again, the form tends to fill the gauge glasses and prevent the driver from ascertaining just how much water is in the boiler.

Priming washes the lubrication off valves and cylinders, wastes fuel and water, and sometimes fractures cylinder covers; to prevent such fractures the cylinder cocks should be opened.

The first indication that priming is likely to occur is usually given by the water in the gauge glass becoming turbid; priming may be detected by a spray at the funnel and by the sound of the exhaust.

Changes in pressure increase the tendency to foam. Therefore the regulator should be opened gradually. If too much water is carried in the boiler it reduces the steam space and thereby increases the tendency to prime.

It is known that priming can be stopped by a dessertspoonful of castor oil placed in the gauge glass or in the tender, but this is objectionable because a film of oil is deposited on tubes and crown plate, reducing the efficiency of the boiler and rendering tubes and crown plate liable to overheating.

Foaming is not caused by matter held in suspension in the boiler water, but by mineral salts or organic matter (nearly always the former) held in solution. The salts that cause foaming consist of (1) an active salt which need only be present in small quantity, say 3 grains per gal.; (2) a passive salt which enables the active one to cause foaming; the passive salt must be present in large quantity, say 200 grains per gal.; but this condition will be satisfied sooner or later by the concentration due to the continued evaporation of water in the boiler. Magnesium carbonate is an active salt, sodium chlorate, common salt is a passive salt. When the concentration of the passive salt becomes great enough to cause priming, the boiler should be blown down to expels some of the concentrated solution. Another remedy is that the water should be first softened and then made neutral with sulphuric acid. This treated water should be used in a boiler from which all scale has been removed, and should not be mixed with other water. It will be seen that this is a remedy that must not be attempted by enginemen, and one that requires some arrangement whereby the engines using it will not leave the district where the treated water is available. It need hardly be added that the judicious use of the blow-off cock and the injector are essential to maintaining safety.

Mistaken Economy.

We lately heard a shop foreman scolding a carpenter for failing to pick up a few nails which he dropped when busy at work. The impression which we received was that the man's work would be reduced by the operation of picking up the nails to an extent that would outbalance the value of a few nails. There are many causes of mistaken economy more pronounced than that of picking up nails and there is no place more likely for them to be found than in the machine shop. Belt laces cost money. When a belt is to be taken up, it may be carefully unlaced and the lace may be used again. The lace is not as good as new if the belt has done any work since the previous lacing, and the lace cannot usually be used again in the same belt, as it will be too short, because the ends necessary to pull it through are usually cut off after each lacing of a joint; still, belt laces cost money and are therefore worth money, and a lace saved is money earned. We have known a funny, nagging shop proprietor when a main belt has slipped off on account of being too slack, stopped the work of a score of men, insist upon the careful unlacing of the belt and the saving of the laces, although it meant the loss of ten minutes to do it.

Files cost money, therefore all the work possible must be got out of them before they are thrown out. Proprietors who complain about their foremen having their file bills too high would often make money if their file bills were double what they are. Machine tools cost money, therefore they must be used until they are worn out, and they never wear out, a policy which keeps our shops filled with tools that individually cannot turn out one-half of a day's work, according to the standard of the more advanced tools and processes.

Patterns cost money, and, therefore must be hung on to until they pay for themselves. Their first making may have been an actual blunder, or they may have been all right at the time, but only one year may have shown that they were obsolete but they must be used.

Tempering Steel.

For most purposes it is necessary to temper tools after hardening, for if left "dead hard," as it is termed, they are very brittle and apt to break, and tempering increases their strength largely. Some turning and planing tools, especially for cast iron, can be left "dead hard," but taps, drills, reamers, screwing dies, etc., should be tempered. The methods of tempering vary somewhat, according to the article, but they mostly consist of brightening part of the article and applying heat. In manufacturing in a large way the degree of heat is often determined by some apparatus,

but in a small way by the color of the oxide. Such articles as screwing or stamping dies, flat cutters, etc., are best tempered by placing them after polishing the upper surface, on a piece of sheet metal over a gas ring, or, if gas is not available, on a large piece of red-hot iron. The work must be watched carefully, and it is well to keep turning it round, end for end, as this prevents one end getting hotter than the other. Dies for screwing, stamping and such articles should be dipped when of a full straw color.

Removing a Stubborn Nut.

The best method of removing a stubborn nut is to heat an open ended wrench that fits the nut, and while hot place it on the nut and allow it to remain for two or three minutes. The heat will cause the nut to expand and it can be taken off with ease. The intense heat of a blow torch has the effect of heating the bolt at the same time, whereas the heated wrench only heats the nut. A nut that resists the hot wrench will probably have to be split to be removed.

Hardening Soft Iron.

Wet the iron with water and scatter over its surface powdered yellow prussiate of potash. Then heat to a cherry red heat, which causes the potash to melt and coat the surface of the soft iron. Then immerse quickly in cold water, and repeat the operation, and a degree of surface hardness will be obtained that would be difficult to surpass.

Removing Grease from Paint.

Washing with cold or hot water not infrequently injures the paint. It is safer to rub the painted surface with a paste or ordinary whiting. When dry and rubbed off with a cloth the dirt and grease are taken away with the whiting.

Pig-Iron.

Pig-iron is a word suggested by the word "sow." When iron is melted, it runs off into a channel called a sow, the lateral branches from which are called pigs. Here the iron cools and is called pig-iron.

Cleaning Brass.

An ounce of alum put into a point of boiling water will clean brass very quickly without harm to the hands or the metal. Stains as well as tarnish are removed by rubbing with a cloth.

"An education," meditatively maintained this descendant of the Cherokee, "is a specific asset to young people in these days, yet how grossly misinterpreted is the word, just as knowledge and wisdom are often confused. In my opinion, the best education is that got by struggling to get it."—Joe Mitchell Chapple.

Railroad Equipment Notes

The Nevada Northern is inquiring for a number of Consolidation locomotives.

The Santa Fe has completed a new machine shop building at its plant at Temple, Tex.

The Paris, Lyons & Mediterranean has ordered 100 Mikado locomotives from the Baldwin Locomotive Works.

The Chicago, Burlington & Quincy has issued inquiries for shop equipment. The list contains about 100 items.

The Delaware, Lackawanna & Western is to expend about $5,000 on improving its roundhouse at Elmira, N. Y.

The Arcade & Attica is to build an enginehouse at Arcade, N. Y., to be 60 by 75 feet, and of cement construction.

The Pennsylvania is to expend about $20,000 on machine shop, roundhouse and passenger station at Jeffersonville, Ind.

The Western Maryland has let a contract for a shop building, 34 by 80 ft., at its Hagerstown shops, costing about $10,000.

The Central Railroad of New Jersey has ordered 250 tons of steel for a power house and 100 tons for a substation at Jersey City, N. J.

The Texas & Pacific, it is reported, will build a roundhouse in connection with plans to improve a 125-acre site for yards at Alexandria, La.

The Missouri Pacific has plans prepared for rebuilding the 10-stall roundhouse at Lake Charles, La., which was burned last January.

The Grand Trunk Pacific is to expend about $250,000 on terminal improvements, including shops, roundhouse, etc., at Prince Rupert, B. C.

The Lehigh Valley has ordered from the General Railway Signal Company a 38-lever interlocking machine, to be installed at Easton, Pa.

The United States Government has ordered for use in France 875 gondolas, and 200 box cars. This is besides the 3,500 ordered some time ago.

The Baltimore & Ohio has ordered from the Union Switch & Signal Company a Saxby & Farmer interlocking, 48 levers, for Outville, Ohio.

The Evans-Thwing Refining Company, Kansas City, Mo., has ordered 50 40-ton, 8,000-gal. capacity tank cars from the American Car & Foundry Company.

The United States Government has ordered 38 cars from the American Car & Foundry Company, including 4 narrow gauge flat cars, 32 standard gauge flats and 2 standard gauge box cars.

The United States Railroad Administration has asked car builders to submit bids on a 50-ton steel sheathed box car in lots of 1,000. Manufacturers received drawings and specifications and were urged to submit their propositions at earliest possible moment.

The Baltimore & Ohio has ordered a 48-lever Saxby & Farmer machine for installation at Outville, Ohio. The field work will be performed by the railroad company's construction forces. The Union Switch & Signal Company is furnishing the machine.

New water tanks on steel towers were erected at Itasca, Wis., Belle Plaine, Windom and Mankato, Minn., and Newcastle, Nebr., replacing old tanks worn out. At Spooner, Wis., a 150,000-gallon steel tank on a steel tower was erected, joint with the city of Spooner.

The placing of contracts for government cars is being somewhat delayed by conferences with the War Industries Board as to the possibility of using steel and lumber which may be needed for shipbuilding. The War Industries Board has the determination of priority on such matters.

Orders have been received by the American Locomotive Company for the following locomotives for the Central Railway of Brazil: 3 Consolidation type locomotives, weighing 165,000 lbs.; 1 Mallet type, weighing 280,000 lbs.; and 2 Consolidation type locomotives, weighing 167,000 lbs.

The Los Angeles & Salt Lake City has offered the following rail for sale for use in necessary industrial, logging and minning tracks and other necessary work: Forty-seven track miles of 75-lb. rail; eight track miles of 60-lb. rail; three track miles of 56-lb. rail and 13 track miles of 52-lb. rail.

The Pennsylvania, Western lines, have recently placed an order with the Union Switch & Signal Company for a 32-lever improved Saxby & Farmer interlocking machine and other materials, to be installed at Smithville, Ohio. The field work will be carried out by the railroad company's regular construction forces.

Books, Bulletins, Catalogues, Etc.

Handbook of Chemistry and Physics, by Chas. D. Hodgman, B.S., and Melville F. Coolbaugh, M.A. Published by the Chemical Rubber Company of Cleveland, Ohio, 1917. Sixth edition. Price, $2.00.

This handbook of 480 pages is a ready reference pocket book of chemical and physical data. The work opens with some plain, highly important information about poisons and their antidotes, and about burns and scalds and what may be called burns by acids or alkalis and their remedies, or readiest method of alleviating the pain so caused. Mathematical tables come next, and these contain examples worked out, mensuration formulas and many other mathematical data, not usually found in other handbooks in the form they are presented here. The composition and physical properties of alloys, and the physical constants of the elements, contains information which, in as compact, yet comprehensive presentation is not to be had in other books. The physical constants of inorganic compounds is treated in the same way and the tables, like the others, are concise and full of things not generally known. Heats of formation and solution of substances is most useful and in this table all the chemical combinations of such substances is fully dealt with. A few interesting pages are devoted to the electromotive force series of metals.

The physical considerations of various substances opens what may be called the Physics section of the book. It is hardly necessary to speak of the properties of matter, the expansion of solids, the properties of water, its vapor tension, the specific heat of gases and the many kindred subjects that have not been forgotten by the authors. All through the handbook there is evidence of careful investigation and painstaking tabulation. Everyone knows that water, free to the air, boils at 212 degs. Fahr., but when it comes to higher or lower temperatures under pressure, or where pure or heavily charged water is dealt with, it is evident that conditions have changed so that careful, quantitative experiment is imperative. This is only given as an example, but it serves to show how the immense variety of subjects is handled. The most reliable data in each case has been collected and set down in order and with system. The book is a highly valuable contribution to the sciences. It is brief and to the point. A comprehensive index rounds up the work and greatly assists the man who uses the book. A few blank pages at the end are supplied for whatever notes, remarks or comments the owner of the book desires to make. The book is worth the price charged and can be had by writing direct to the publishing firm in Cleveland.

Bridge Engineering, by J. A. L. Waddell, C.E., B.A.Sc., Ma.E., D.Sc., 2 vols., 2,252 pages. 6 by 9. Illustrated. Cloth binding. Published by John Wylie & Sons,, Inc., New York. Net, $10.

In this book the author gives all the information that he has accumulated during forty years. It is a useful book for all engineers who are engaged, either directly or indirectly in designing or building bridges and especially to young professional men. Not only are the principles of design explained and exemplified, but also many practical hints are given.

The book, of which there are two volumes, was not prepared as a text-book for engineering students, but is well adapted to supplement any of the treatises used in the classroom to-day.

This book is not a text-book, or a mere summary, it is really a synoptic analecta. It contains the results of a long and busy professional life. Dr. Waddell has looked at his subject understandingly, not with mere interest, he has brought keen observation to bear on the matter, not a mere cursory examination, he has tabulated results and drawn conclusions, and has not been content with compiling mere extensive statistics. His minute researches are the more valuable because what he has seen and experienced have not only been fully set forth, but they have been interpreted.

The extent of the phases of the whole matter of bridge building, may be judged when we say that there are eighty chapters, a very comprehensive glossary of terms, and an index. The author has done much good work improving the advantages of alloy steel containing nickel, vanadium and chromium or such combination of these as are suitable for long spans. Alloy steel having the quality of raising the elastic limit, permits high working stresses and a reduction in weight. The weight of the long girder causes the greater part of the stresses which have to be resisted, and these are in excess of those due to wind pressure or the moving load.

One may safely say that there is practically not a bridge-building condition which has not been dealt with by the practical author, and hints for the beginner are given. The work all through may be simply said to be complete, and one which is well written, with an intelligent and painstaking effort to leave nothing out of sight. The statements are nowhere the results of guesswork, they are the result of carefully applied and minute analysis which cannot fail to be of the highest value to the student, the searcher for truth and the professional man.

Psychology, by Prof. B. B. Breese. Publishers Charles Scribner's Sons. Illustrated. New York, 1918. Price, $2.00.

This book, so the preface informs us, is intended to give a comprehensive view of the facts, principles, and theories of human psychology. There are twenty chapters and an index, making 482 pages in all. The chapter No. 3, on attention, is, if one may say so, worth the price of the book. This subject is clearly dealt with and it is very important for it strikes the reader, even though he be not a psychologist, and it "comes within his ken."

There is one charisteristic of attention, says Prof. Breese, and that is clearness. It is always present. Attention itself is clear consciousness. We are more clearly conscious of some objects than others, of some topics of thought than we are of others. Clearness must not be confounded with high intensity. A low degree of sensation may be perfectly clear in consciousness, or a high degree of sensation may not be attended to at all; it may not be clear. The pop of a firecracker may be perfectly clear in consciousness, while the boom of the cannon, fired to mark noon, may not be heeded and therefore not be clear. The sound may have high intensity but low clearness in the mind.

It is true that high intensity usually attracts attention and becomes clear, and it is true that low intensity escapes attention. Clearness and intensity are different attributes of consciousness.

It is a common belief in popular thought that the degree of attention is proportionate to the effort expended in attending. This is true only within very narrow limits. In voluntary attention it requires effort to direct and hold the attention. In the higher degrees of attention, and in rapt and absorbed attention there is no effort at all. If one becomes deeply attentive all effort to attend disappears. A measure of attention is to note the strength of the distracting influence, necessary to produce a decrease in efficiency.

This is of the utmost importance, and we, of the railway world, may note either with sorrow or satisfaction the inroads that a distracting influence may make or may be resisted by a man in the cab of an engine as he is called on to give his attention, observe and obey the signals on the road over which he and his engine and train are rapidly moving.

The other chapters in this book deal with their designated subjects in the same frank, open and commonsense way that the important subject of attention is here handled.

The Volatile Matter in Coal.

Technical Paper, No. 183, issued by the Bureau of Mines, embodies "New Views of the Combustion of the Volatile Matter in Coal," by S. H. Katz. The paper is one of a series issued from the Government press, containing the results of analyzing and testing fuels belonging to or for the use of the Government with the purpose of determining how these fuels may be utilized most efficiently. The paper deals exclusively with volatilization of the hydrocarbons in coal, and the burning of the volatile matter in the combustion space of the furnace. A careful persual of the paper gives a conception of the reactions and equilibriums of the mattter which composes a fire. These reactions are very complex, and much of the reasoning is speculative, but the aim is to correct error by disseminating the best information obtainable. Copies may be had from the Superintendent of Documents, Government Printing Office, Washington, D. C.

The New York Traction Problem.

Mr. Theodore P. Shonts, president of the Interborough Rapid Transit Company, is a voluminous writer on transportation subjects, and his most recent effort takes the form of a twenty-eight page pamphlet, setting forth in detail the difficulties in the rapid transit problem in New York City and vicinity. With express trains 700 feet long, running every two minutes, and locals 500 feet long, every three minutes, it is the most intense passenger traffic in the world, and no more could be done with the existing roads. It only remains to extend the system and this is being done. So far the facilities for rapid transit have not kept pace with the increase of population. Mr. Shonts claims that transit facilities attract population, but the growth of New York City is inevitable, and in the clamor for better facilities for travel no scheme for overtaking the growth of the city has yet been evolved. One architectural genius is attempting to induce the commercial portion of the community to content themselves by living near their work instead of trying to get as far away as possible, and has succeeded in building accommodation for a few hundred in the lower part of the city. We doubt the success of his experiment. City people will rush to the suburbs, just as rurals will go to the town when the day's work is done. Systems of transit may change, but human nature cannot be changed.

Graphite.

The use of graphite as an aid to lubrication has been so thoroughly explained in the Joseph Dixon Crucible Company's periodical *Graphite*, that the advantages in its use are now beyond controversy. In using the thin flake graphite the flakes are caught in the microscopical irregularities of the bearing surfaces and form a veneer-like coating of marvelous smoothness and endurance. Not only in metal

bearings, but, as we have stated before, as an air-brake cylinder lubricant the graphite attaches itself to the leathers as well as to the surfaces and cylinder walls. The result is that brake cylinder leakage is reduced to a minimum, leathers are always kept soft and pliable, and brakes respond accurately to all pressure variations, because the parts are moving on graphite rather than leather on metal.

Tests of Varying Sizes of Coal.

Bulletin No. 101, entitled "Comparative Tests of Six Sizes of Illinois Coal On a Mikado Locomotive," describes in detail a series of tests to determine the value of different sizes of coal, conducted by the Engineering Experiment Station of the University of Illinois under an agreement with the International Railway Fuel Association and the United States Bureau of Mines. As is well known the relative values of several sizes of coal for locomotive use have not been as well understood as they might have been, as most tests have been made with mine-run or occasionally with lump coal, and the data heretofore published are inadequate and conflicting. The introduction of the mechanical stoker for locomotives has resulted in the use of various sizes of screenings. The Bulletin is of special value as furnishing reliable data on the subject to which it is devoted, and copies may be had without charge from the Engineering Experiment Station, Urbana, Ill.

Staybolts.

The April issue of *Staybolts*, published by the Flannery Bolt Company, Pittsburgh, Pa., contains a full reprint of a report presented by a special committee of the Master Boiler Makers' Association at their convention held in Chicago in May, 1913. It points out with great clearness and conciseness that a boiler explosion is never an accident, and is always preventable because it arises from a cause that might have been foreseen. The defect could have been remedied and the explosion prevented. The principal causes of weakness are: Weakness and defect in the design, construction or workmanship, improper treatment, carelessness, neglect or ignorance on the part of the boiler attendant, wasting from wear, tear and corrosion, overpressure, worn-out condition and overheating from lack of water, defective condition of safety valves and other mountings, exposure to conditions which cause development of defects, or a general deterioration of the boiler. The Tate flexible staybolt is also fully described and illustrated in the issue. The growing popularity of the use of the flexible staybolt is the best proof of its merit. Copies of the issue may be had on application by addressing the company's main office at Pittsburgh.

Lighting for Production and Safety.

The Cooper-Hewitt Electric Company, Hoboken, N. J., has done an excellent service to all who are interested in the selection of a system of illumination with a view to ultimate efficiency of the plant by publishing an admirable paper on the subject from the pen of William A. D. Evans, an eminent authority on the matter. Five fine illustrations and numerous diagrams illustrate the work, all tending to show that daylight can be surpassed, because sunshine in all its brilliancy being single, casts shadows, whereas the electric lamps arrayed along the walls and between the bays preclude the possibility of shadows. The tubular shape of the Cooper-Hewitt lamp particularly adapts itself to this form of fighting, and statistics show that a greater degree of efficiency is immediately recognized where it is established.

Save the Concrete.

The E. I. du Pont de Nemours & Company, Wilmington, Del., publish a circular in regard to the chipping of concrete on account of the freezing action causing cracks to appear. This chipping and cracking of the surface of the concrete detracts from the appearance and the strength of the concrete. A sure way to prevent this destructive action is to thoroughly coat the surface of the concrete with a floor dressing paint. This coating preserves the texture and individuality of the concrete and prevents all moisture from penetrating the surface. If new concrete floors are covered with two coats of this paint and recoated at intervals of about six months the concrete surface will remain unscarred and without cracks. The use of this "crack preventative" is becoming greater each year and many factories use it in large amounts.

War Gardens.

Owing to the success of the War Garden scheme proposed by the Pennsylvania railroad last year to the employees over 1,200 gardens on company land raised crops estimated at one-quarter of a million dollars in value. This record is expected to be surpassed this year, as the good work is being taken up all along the line.

The Late James Hill on Success.

"If you want to know whether you are going to be a success, you can easily find out. Are you able to save money? If not, drop out. You will fail as sure as you live. The seed of success is not in you."

Little minds are tamed and subdued by misfortune. Great minds rise above it.

Statement of the ownership, management, etc., required by the act of Congress of August 24, 1912, of RAILWAY AND LOCOMOTIVE ENGINEERING, *published monthly at New York, N. Y., for April* 1, 1918.

State of New York }
County of New York } *ss.*

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Harry A. Kenney, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the RAILWAY AND LOCOMOTIVE ENGINEERING, *and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act, of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:*

1. *That the names and addresses of the publisher, editor, managing editor and business managers are: Publisher, Angus Sinclair Co., Inc.,* 114 *Liberty St., New York, N. Y.; Editor, Angus Sinclair,* 114 *Liberty St., New York, N. Y.; Managing Editor, James Kennedy,* 114 *Liberty St., New York, N. Y.; Business Manager, Harry A. Kenney,* 114 *Liberty St., New York, N. Y.*

2. *That the owners are: Angus Sinclair Co., Inc.,* 114 *Liberty St., New York, N. Y. Stockholders owning* 1 *per cent. of the total amount of stock: Angus Sinclair,* 114 *Liberty St., New York, N. Y.; James Kennedy,* 114 *Liberty St., New York, N. Y.; Harry A. Kenney,* 114 *Liberty St., New York, N. Y.; Mrs. O. J. Schanbacher,* 40 *Heddon Terrace, Newark, N. J.*

3. *That the known bondholders, mortgagees and other security holders owning or holding* 1 *per cent. or more of the total amount of bonds, mortgages, or other securities are: None.*

4. *That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the Company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and that this affiant has no reason to believe that any other person, association or corporation has any interest direct or indirect in the said stock, bonds or other securities than as so stated by him.*

[SEAL.] HARRY A. KENNEY,
Business Manager,

Sworn to and subscribed before me this fifteenth day of April, 1918.

OLIVER R. GRANT,
Notary Public,
My commission expires March 30, 1919.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXI 114 Liberty Street, New York, June, 1918 No. 6

Chestnut Hill Electrification, P. R. R.

The Chestnut Hill line on the P. R. R. is an extension of the Philadelphia Paoli Electrification and connects with the same line at a point near West Philadelphia, and extends over the main line to North Philadelphia and over the Chestnut Hill Branch to Chestnut Hill. The distance from Broad street to Chestnut Hill is 12 miles. The length of the new electrified Chestnut Hill line is 10 miles, 2.3 miles of which is four track and 7.7 miles two track. There are at present in daily operation 21 trains, totaling 88 cars, in each direction. The electric equipment is intended to handle a service of 32 trains each way per day, the rush-hour service being eight-car trains on a five-minute interval.

The average grade between North Philadelphia and the junction with the Philadelphia Paoli Electrification is .33 per cent, and the maximum grade is 1.3 per cent., near the easterly approach to 36th Street Tunnel. The difference in elevation between the junction of the Chestnut Hill Branch with the main line at North Philadelphia and the end of the track at Chestnut Hill is 297 feet, or an average grade of .84 per cent. The maximum grade on this branch is 2.5 per cent between Highland Station and Chestnut Hill. Of the total of 12 miles of the Chestnut Hill Electrification, eight miles are on tangent and four miles on curved track. The heaviest curve at North Philadelphia is 11 degs. and is about .2 miles in length. The remaining curve track varies from 40 min. to 5 degs. 20 min., most of which is on rising grade. There are 11 stations on the Chestnut Hill Branch, spaced about one-half mile apart, except in one case, where

OUTDOOR TRANSFORMER STATION AT NORTH PHILADELPHIA—P. R. R. ELECTRIFICATION.

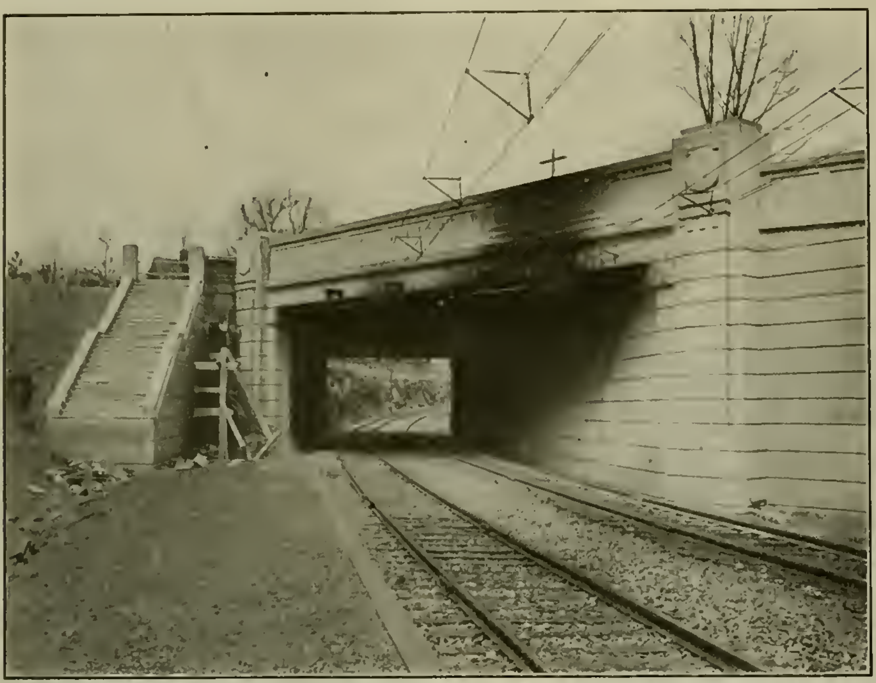
the distance between stations is one and one-half miles.

Power for the Chestnut Hill Electrification is furnished by the Philadelphia Electric Company. This power station is on the east bank of the Schuylkill River at Arsenal Bridge. Three-phase power is generated here at 13,200 volts, and is transmitted over four 350,000 c. m. three conductor submarine cables to the Arsenal Bridge transformer station, which is located on the west bank of the river, about opposite the power house. Power for the Paoli Electrification was taken from one phase of the Philadelphia Electric Company's system. With the Chestnut Hill load added, the three-phase power is transmitted to the Arsenal Bridge transformer station, where two groups of Scott connected transformers are employed for transforming the supply into two-phase 44,000 volt power.

wire, from the source of supply at West Philadelphia transformer station. The transmission lines are protected by a ⅜ in. Siemens-Martin galvanized steel ground wire carried on top of the transmission poles.

A safety tying system of special design is used on both the power and signal transmission lines on poles adjacent to highway crossings and station platforms in order to insure against burning off and falling of wires in case of insulator failures. These safety ties consist of flat galvanized iron plates, 3½ ins. wide placed under and clamped to the transmission wire and to yokes on the insulators. The plates extend about 18 ins. beyond the insulators. Two insulators are used at highway crossings and on sharp curves.

The equipment in the West Philadelphia transformer station originally con-



CATENARY CONSTRUCTION SHOWING SUSPENDED WIRES UNDER LOW OVERHEAD HIGHWAY BRIDGE.

Phase balancers are installed in the Philadelphia Electric Company's power house to correct the unbalancing which occurs due to the variation in load requirements of the Paoli and Chestnut Hill systems.

For the Chestnut Hill supply, transmission lines are of stranded aluminum steel reinforced wires, having a conductivity equivalent to No. 00 copper, carried on cross-arms on separate transmission poles. A signal power line of stranded aluminum steel reinforced wires, having a conductivity equivalent to No. 0 copper, is carried from North Philadelphia to Chestnut Hill on cross-arms placed on the transmission poles below the power transmission cross-arms. The signal power line of insulated copper

sisted of two 2,000 kva oil insulated water-cooled step-down transformers. In order to take care of the Chestnut Hill Electrification, two 3,000 kva. oil-insulated water-cooled transformers were installed in this transformer station and connected to the Paoli phase. The two 2,000 kva. transformers which they replaced were connected to the two Chestnut Hill transmission lines and trolleys. All of the transformer station apparatus is designed for outdoor service. The terminals on all transformers and oil circuit breakers are equipped with high voltage porcelain insulators, and all of the live parts and operating mechanisms are enclosed in weatherproof cases. The transformer station equipment is protected from lightning discharges and surges by means of electrolytic lightning arresters on the high tension and trolley feeders. In each of the transformer stations there is a small brick or concrete building in which the relays for automatic circuit breaker tripping and the magnet or relay switches for closing the oil circuit breakers are located. These buildings also contain filter press for cleaning and drying the oil in the transformers and oil circuit breakers. In the case of the Allen Lane transformer station the building also contains a small storage battery and motor generator set for charging the battery, which is used for automatic circuit breaker tripping. Power for this purpose in the case of the North Philadelphia transformer station is obtained from a storage battery in GD signal tower. Each transformer section is equipped with a large tank of sufficient capacity to hold the oil from one transformer, and, in addition to this, small tanks are provided into which the oil from circuit breakers is pumped for cleaning and drying.

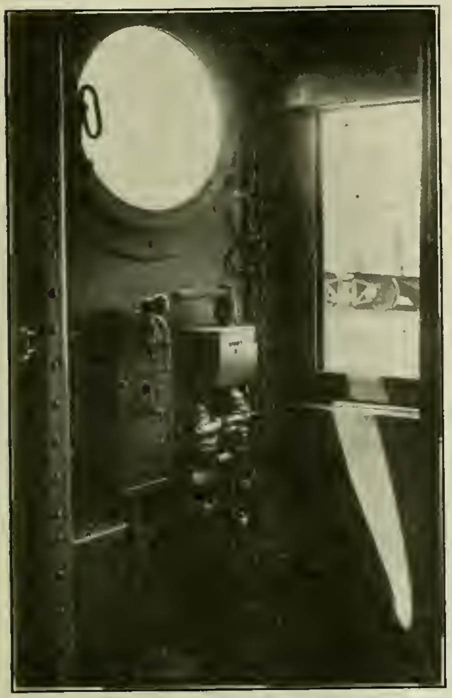
The catenary system is carried on bridges spaced about 300 feet apart. Catenary construction consists of a steel supporting wire, secondary messenger wires or auxiliary trolley and a contact trolley wire. The secondary messenger and contact trolley are clamped together with bronze clamps, spaced 15 ft. apart, and both are supported from the messenger by flat steel galvanized hangers every 30. ft. on tangent track, and 15 ft. on curved track. The catenary is anchored approximately every mile on either overhead highway bridges or signal bridges designed to support the catenary over all tracks on either side of the bridge in case of a break in the catenary system on the opposite side. Catenary supporting bridges are of several types, designed to fit different conditions and locations. Wherever possible tubular pole construction with guys is used.

The tubular pole bracket type of construction is used extensively for supporting the catenary over the two tracks on the branch. Structural poles and extra heavy tubular poles, bracket type construction, without guys, are used over the two track construction on the branch where space will not permit the use of guys.

The messenger wire is of ½-in. extra high strength seven-wire steel strand galvanized, having a breaking strength of 27,000 lbs. The secondary messenger is of No. 00 grooved copper wire. The contact trolley is of No. 000 grooved copper alloy (phono-electric) wire. The cross catenary structures consist of a messenger wire of ¾ in. extra high strength 19-wire steel strand galvanized with a body strand of ½ in. diameter wire of same material. The catenary system is insulated from supporting

bridges by three shell suspension type Locke insulators. It is insulated from the overhead highway bridges by Ohio Brass post type insulators.

The rails of the main line tracks are double bonded at each joint with two pin-type expanded terminal bonds of No. 1/0 B. & S. Gauge, each bond consisting



INSIDE OF MOTORMAN'S BOX.

of 37 strands of soft-drawn copper wire. The rails carrying the propulsion current return are sectionalized at each signal block; the propulsion current flowing through impedance bonds which are connected around these points. These impedance bonds are designed to allow the flow of propulsion current and to sectionalize track against the flow of the 60-cycle signal current.

The multiple unit car equipments are similar to the car equipments used for the Paoli Electrification, except in the following principles: The compressor is driven from a separate motor instead of from the blower shaft. The main transformer is designed to operate on a lower mganetizing current and the insulation improved. Preventative coils are used in connection with switch groups instead of resistances, resulting in a reduced power consumption. A low voltage relay is provided, making it possible to operate cars with 1,000 volt greater variation trolley potential. Increased illumination is provided in the cars. Car inspection and repairs will be conducted in the car inspection building located in Paoli yard, where the inspection and repairs for the equipments of the Paoli line is also done. The multiple unit cars which are used on both the Paoli and Chestnut Hill lines are interchangeable for either line, and the repairs and maintenance to same will be handled in the one inspection building. The maintenance of the Chestnut Hill line equipment will be handled by the same maintenance force as formerly handled the maintenance of the Paoli line, its headquarters being at West Philadelphia.

The design and construction was conducted by Gibbs & Hill, consulting electrical engineers for the Pennsylvania Railroad Company, in the same manner as the Philadelphia Paoli installation. The multiple unit car equipments were installed by the railroad company at the Altoona shops. All signal equipment and the necessary work in connection with telephone and telegraph lines was done under the direction of the railroad signal and telegraph departments. The motor car equipments, transformer station equipment was supplied by the Westinghouse Electric & Manufacturing Company. Structural poles and signal bridges by the Lackawanna Bridge Company. Miscellaneous structural material, consisting of highway bridge supports, substation structural material, protection screens, Steward & Stevens Iron Works and Belmont Iron Works. Tubular poles, National Tube Company. Steel messenger, cross span and ground wire, J. A. Roebling's Sons Co. Aluminum transmission wire and fittings, Aluminum Co. of America. Contact trolley wire, Bridgeport Brass Company. Secondary messenger wire, Waclarke Wire Company. Bonds, American Steel Wire Company, Electric Service Supplies Company, Ohio Brass Company. Insulators, Locke Insulator Manufacturing Company, Ohio Brass Company. Guy rods, Oliver Iron & Steel Company. Steel castings, Atlantic Steel Castings Company. Malleable iron castings, Eastern Malleable Iron Company. Catenary hangers, West Philadelphia Shops, Pennsylvania Railroad Co. Bronze hanger clip castings, Altoona Shops, Pennsylvania Railroad Co. Catenary fittings, bolts, nuts, hanger rods, pull-off rods, etc., West Philadelphia

MOTORMAN IN POSITION—P. R. R.

Shops, Pennsylvania Railroad Co., American Iron & Steel Co. Sockets and turnbuckles, Thomas Laughlin & Co., J. A. Roebling's Sons Company. Block and automatic signal equipment, Union Switch & Signal Company.

Radiant Heat and Firebox Design

The Central Railway Club, of Buffalo, listened to a paper prepared by Mr. J. T. Anthony, assistant to the president of the American Arch Co., on Radiant Heat and Firebox Design, a short resumé of which we give. Mr. Anthony said, in effect, that the terms, "radiant heat," "heat of convection" and "heat of conduction" are not descriptive of different kinds of heat, but of different methods of heat transfer. Heat is conducted from the hot part of a body to a cooler part by the vibration of the molecules within that body. An iron rod, for instance, with one end subjected to heat is rapidly heated up throughout its entire length by conduction of heat from one particle (or molecule) to another.

"Heat of convection" means heat that is conveyed from one body to another or to the same body by means of currents of hot liquid mingling with the cooler parts. "Radiant heat" is descriptive of a method of heat transfer which we call by this name; heat passing from the hot to the cooler body without the aid of any material substance (in the ordinary sense of the word); the most familiar example of this being the radiation of light and heat from the sun to the earth through a space of about 93 millions of miles at a speed of 186,000 miles a second. As our atmosphere is said to extend only about 50 miles above the earth's surface, the intervening space between the earth and the sun is (so far as we

know) filled with elastic ether by which the heat and light are transmitted.

Heat is a form of energy. We cannot conceive of energy or force acting through space without the aid of some medium. That medium is ether. In order to get some idea of radiation, it is necessary to know something about the body of matter that is giving off heat. Matter, in whatever form it is found, is composed of small particles called molecules. These molecules are made up of still smaller particles called atoms, and atoms are composed of still smaller particles of electricity. We know that there are two kinds of electricity, positive and negative. Both kinds enter into the structure of an atom, these particles of electricity being known as electrons. The center, or core, of the atom is composed of both positive and negative electrons. Revolving around this as a nucleus, are negative electrons. The outer electrons by their revolutions form the surface of the atom. It is well known that opposite kinds of electricity have an attraction for each other, while the same kinds of electricity repel each other. It is believed that the vibration of these negative electrons set up the ether waves that act as the conveyors of radient heat.

With such a structure in mind, we can get some idea of how the electrons vibrating within the atom would strike tightly stretched suppositious threads of ether, causing them to vibrate, and so set up waves.

A stream of cold air rushing through an open fire door to the flues, is comparatively unaffected by the heat rising from the fuel bed and flames, and can only be warmed by mixing it intimately with the hot gases in the firebox. Burning gas, or flame, both absorbs and emits heat, but the instant the flame goes out and the gases become transparent, radiation ceases. This property of gases has an important bearing on firebox design. The process of radiation is illustrated in Fig. 1. Suppose that the atom A was

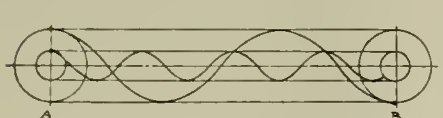


FIG. 1. PROCESS OF RADIATION.

in the hot body and its electrons were vibrating rapidly. They would strike the imaginary ether threads, and set up waves that would travel out in all directions, and some of them would strike on B. The electrons revolving rapidly in a small orbit set up short waves of great frequency, while the electrons revolving less rapidly in a larger orbit will set up longer waves of lower frequency. The longest waves known, such as the "wireless" wave, may be more than a mile long, producing about 186,000 oscillations per second; while some of the shorter ultra-violet light is produced by more than three thousand billion oscillations per second. In the visible spectrum there are seven colors, each of which corresponds to a different wave-length.

Color	Waves per in.	Waves per sec.
Red	About 34,000	About 400 billions
Orange	" 37,000	" 440 "
Yellow	" 42,000	" 500 "
Green	" 48,000	" 570 "
Blue	" 51,000	" 600 "
Indigo	" 61,000	" 700 "
Violet	" 64,000	" 750 "

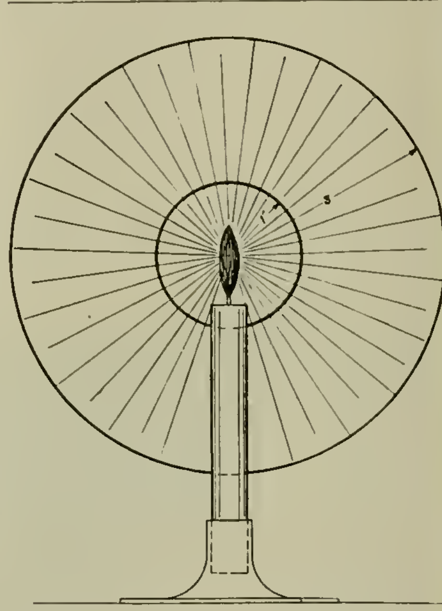


FIG. 2. DIMINISHING INTENSITY WITH DISTANCE.

The figures in the last column are, of course, equal to the number of vibrations of the electrons that produce the ether waves, and will give some idea of the enormous activity of these negative particles of electricity.

A perfectly "black body" is one that absorbs all waves falling upon it and reflects none. In a locomotive firebox we approach very closely to the ideal black body, practically all the heat radiated from the glowing fuel bed and the flames is absorbed by the surrounding soot-covered surfaces. The amount of heat so absorbed depends on the area of the radiating surfaces, and on the temperature. If we increase the firebox heating surface without increasing the area of the heat radiating surfaces or their temperature, there will be practically no increase in the amount of heat radiated.

Fig. 2 shows that if the candle flame were entirely surrounded by a perfectly opaque sphere that absorbed all the heat, the amount of heat absorbed would depend upon the amount radiated from the flame.

The intensity of the heat diminishes as the distance increases; that is, the total number of heat rays passing through a sq. in. or sq. ft. of surface decreases as the distance increases, but the total amount of heat radiated remains the same, and this is the controlling factor. If we were using a coke or a hard coal that burns without any flame, the total amount of radiating surface would be equal to the grate area, and increasing the firebox heating surface would have but little effect on evaporation. When using a high volatile coal, however, the heat radiated from the fuel bed can be disregarded, for in this case the temperature and extent of the flames become the controlling factor.

Increasing the firebox volume is generally accompanied by an increase in heating surface, but the increase in heating surface is incidental to the increase in volume, and it is the volume that is responsible for the increase in radiating surface and increased firebox evaporation. The installation of a combustion chamber results in an increase of both volume and heating surface, but the added heating surface is of little value if the firebox volume is not utilized and filled with flame. With a restricted air opening or a heavy fire, much of the fixed carbon is incompletely burned to carbon monoxide; and this combustible gas must then be burned in the space above the fuel bed, in addition to the hydrocarbons.

With a fair grade of bituminous coal and ordinary firing methods, fully 50 per cent of the heat generated in the firebox is due to the burning of combustible gases above the fuel bed; and in order to burn them completely, it is necessary to have an adequate supply of oxygen above the fuel bed. The more intimate the mixing

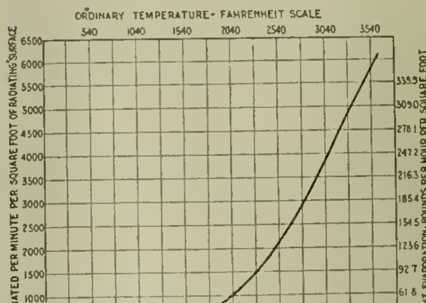


FIG. 3. TEMP. DIAGRAM SHOWING B. T. Us. RADIATED PER MINUTE PER SQ. FT. RAD. SURFACE.

of the gases and the greater the supply of oxygen, the quicker will the flame burn and the shorter will be its length. Otherwise combustion is apt to be incomplete. These latter conditions generally prevail in a locomotive firebox, for it has proved very difficult, if not impossible, to get sufficient oxygen above the fuel bed at moderate or high rates of firing, and to thor-

oughly mix the oxygen with the combustible gases in the time required.

The brick arch has proved to be a very effective gas mixer; but the lack of air or oxygen can only be offset (or partly offset) by increasing the firebox volume, by adding a combustion chamber and thereby increasing the time available for the completion of combustion.

The effect of temperature upon the amount of heat radiated is shown in Fig. 3, the points determining the curve having been calculated from the Stefan-Boltzmann formula, where the heat radiated per square foot of radiating surface is equal to the difference between the fourth powers of the absolute temperatures of the radiating body and the receiving body, multiplied by a constant. The figures at the left show the heat units radiated per minute per square foot of radiating surface at the different temperatures, while the figures at the right show the corresponding equivalent evaporation in pounds per hour per square foot of radiating surface, the radiating surface being the fuel bed or the exposed flame surface. Increasing the temperature from 1,500 to 2,000 degs. Fahr. more than doubles the evaporation, while increasing it from 1,500 to 2,500 degs. increases the evaporation four times.

If we know the average firebox temperature and the area of the radiating surfaces, we can approximate with a fair degree of accuracy, the total amount of heat radiated to the firebox surfaces and the amount of water evaporated by the firebox surfaces; or if we know the temperature of the gases entering the flues or the temperature of the gases at the front end and the analyses of the gases, we can, after establishing a heat balance, roughly calculate the total evaporation from the flues. This amount, subtracted from the total boiler evaporation, will give us the firebox evaporation.

The latter method has been used in analyzing test data on a Pacific locomotive in order to determine approximately the relative value of firebox and tube heating surfaces. The locomotive in question had a grate area of 70 sq ft., barrel combustion chamber 36 ins. long, flues 19 ft. long, 2¼ ins. in diameter, total firebox and combustion chamber heating surface 307 sq. ft., total flue heating surface 4,557 sq. ft. Using a formula proposed by Profs. Fessenden and Haney, as the result of tests at the University of Missouri, on heat transmission through boiler tubes, the tube evaporation was calculated for the varying rates of combustion and these were subtracted from the total evaporation to get the firebox evaporation. The results in pounds of water evaporated per square foot of heating surface showed that the evaporation per square foot of tube heating surface varied from 1½ to 11 pounds per hour, while the actual evaporation per square foot of firebox heating surface varied from 42 to 91 lbs. per square foot of heating surface per hour, as the rate of combustion increased from 30 to 170 lbs. of coal per square foot of grate. On a basis of equivalent evaporation, the firebox absorbed from 66 per cent of the total heat at the low rates to 39 per cent at the highest rate.

The coal as fired had a heat value of about 14,300 B. T. U.; firebox temperatures ranged from 2,150 to 2,570 degs. Fahr.; total pounds of gas per pound of coal fired varied from 14 to 8, when burning 160 lbs. coal per square foot of grate per hour (or a total of 11,200 lbs. of coal per hour, the firebox had an equivalent evaporation of 33,400 lbs., while the tubes evaporated 50,800 lbs. The total evaporation from the boiler being 84,200 lbs. per hour. Assuming that the firebox was completely filled with flame, the flame radiating surfaces equal the firebox heating surfaces, or 307 sq. ft., and the equivalent evaporation per hour per square foot of firebox heating surface was about 109 tubes evaporated 89.1 per cent of the total; the firebox and first 15 ft. of tubes evaporated 96.6 per cent of the total; while the last four 1-ft. sections adjacent to front end accounted for only 3.4 per cent of the total. This was with 19 ft. 2¼ ins. tubes. These figures indicate the relative value of the different heating surface locations, and show conclusively the value of combustion chamber and firebox heating surface exposed to the action of radiant heat, as compared to heating surface gained by the use of long flues.

So far, no attempts have been made to establish a definite relation between combustion chamber length and flue lengths; or between the length of firebox from door sheet to flue sheet and length of tubes. These proportions of course should vary with the nature of the fuel used. When using bituminous coal, the indications are that the firebox from door sheet to flue sheet should be approximately as long as the tubes, and in some cases it could no doubt be made longer.

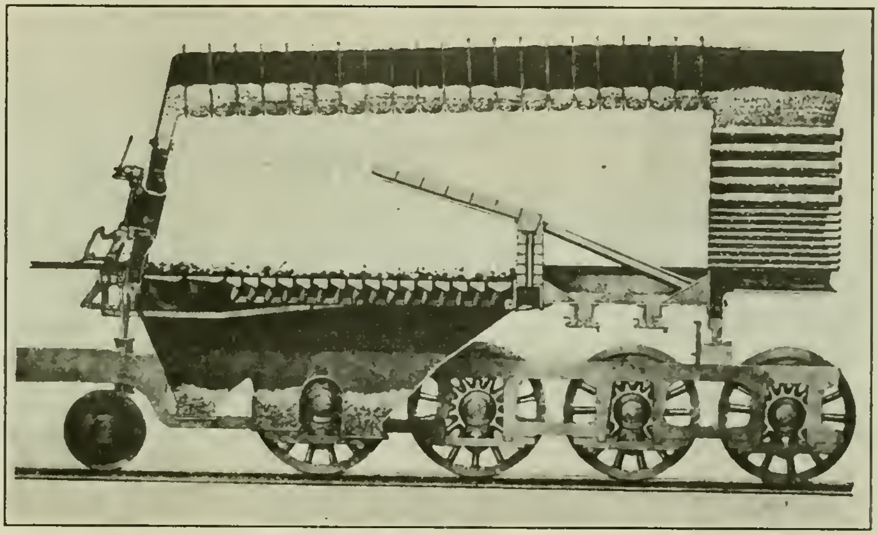


FIG. 4. TYPICAL FURNACE, BRICK ARCH AND COMBUSTION CHAMBER.

lbs. At this rate each square foot of firebox heating surface absorbed 105,730 heat units per hour; and since the effective flame-radiating surface equals the firebox heating surface, each square foot of radiating surface was radiating at the rate of 105,730 heat units per hour, or 1,762 heat units per minute.

In order to radiate this much heat, an average temperature of 2,400 degs. Fahr. was required; while during the test in question the pyrometer located at the end of the arch indicated a temperature of about 2,550 degs.

The resulting evaporations per 1-ft. section of flues run from 8,210 lbs. per hour from the first 1-ft. section to 620 lbs. per hour in the last 1-ft. section; giving an equivalent evaporation per square foot of tube heating surface of from 34 lbs. per hour in section adjacent to firebox to 2½ lbs. per hour in the section next to the front end. The firebox and first 10 ft. of

This statement is based not solely upon the value of the different heating surfaces, but also upon the fact that locomotive boiler efficiency is governed primarily by the furnace efficiency, and high furnace efficiency cannot be obtained without ample firebox volume. There is no logical reason for applying long flues and providing large areas of heating surface before adequate provision has been made for a firebox that will burn the coal and liberate all the heat contained. Tests conducted both in this country and abroad show clearly that nothing is to be gained by increasing the flue lengths beyond 18 or 19 ft. Tests have likewise shown the advantage of a combustion chamber in increasing boiler capacity.

As shown by evaporation curves, the boiler without a combustion chamber, reached its maximum capacity at a rate of combustion of 135 lbs. of coal per square foot of grate; while the combustion cham-

ber boiler continued to increase in capacity even at a rate of 160 lbs. This indicates that the firebox of boiler without combustion chamber could not be forced beyond a rate of 135 lbs., and even at that rate its furnace efficiency was only 62 per cent., while that of the combustion chamber boiler was 74 per cent. This difference may not have been due entirely to the combustion chamber, but it was due to an improvement in combustion conditions which resulted in higher temperatures and increase in radiating surfaces.

In this presentation of the case we have touched only upon some of the important features of the firebox and boiler question. We have much yet to learn concerning the transfer of heat, and more to learn about the generation of heat. The proper proportioning of grate areas, firebox volumes, combustion chamber lengths, cross section areas and shapes of flame passages, etc., are problems yet to be worked out; but the evidence we have points to the fact that the firebox is at present, to say the least, efficient; that the fuel bed is but little more than a gas producer and that provision must be made for burning the large volumes of gas above the fuel bed. The recent action of the Standardization Committee in specifying combustion chambers for government locomotives (except the switching type) will probably give added impetus to the use of such fireboxes. This will, no doubt, result in boilers of greater capacity and efficiency being designed, but also in reducing engine failures, maintenance costs, and terminal delays.

No Man Can Serve Two Masters

The Director General of Railroads has lately issued an order from which the following is taken:—

"In view of the direct responsibility for the operation of the railroads of the country placed upon Director General McAdoo by the act of Congress and by the proclamations of the President, he has been unable to escape the conclusion that it will be advisable to place in direct charge of each property for operating purposes a representative, to be known as the Federal Manager, who will report to the Regional Director. As far as practicable, this Federal Manager will be chosen from the operating officers of the particular property, who are therefore entirely familiar with its employees and with its conditions.

"Except so far as may be necessary to meet the emergency conditions which compel the government to take control of the railroads, the Federal Manager of each railroad will endeavor to avail himself to the fullest extent of the advantages incident to the operation of the particular railroad as a unit and the preservation of its identity. This is believed to be of essential importance, not only to secure the best results during the period of government control, but also to give the greatest degree of reassurance to the officers and employees that the railroad careers upon which they have entered will not be narrowed, but, if anything, will be broadened, and to give the greatest possible reassurance to the stockholders that their just interests in the properties will be respected and that nothing will be needlessly done to have even the appearance of impairing their just rights.

"While in this way the responsibility for the operation of the property will be directly to the Regional Directors, and not to the boards of directors, it is the purpose of the Director General to accord to the boards of direcors and their representatives the fullest opportunity to keep advised as to the operation and improvement of the properties and to maintain with the Director General and the Regional Directors the fullest interchange of views as to what is in the best interest of the government and of the stockholders.

"In the development of this policy the Regional Direcors, and also the Federal Managers, will be required to sever their official relations with the particular companies and to become exclusive representatives of the United States Railroad Administration."

Great Is Diana of the Ephesians.

When Paul preached in Ephesus, the cry of Demetrius, who made silver shrines for the worshipers of the goddess Diana, voiced in essence what has been recently heard in the railway world. It now as then, "This our craft is in danger." In our day the Government of the United States has taken over our transportation systems, and has broached the question of standardization and has been quoted as adverse to the payment of legitimate royalties on patented articles. How that strange idea got abroad we need not now stop to consider. It was started somehow and found a lodgment in the minds of many. As in the case of the Ephesian uproar, so without investigation, the curious power of mob psychology manifested itself, and the bulk of those supposed to be affected knew not wherefore they were come together, but were ready to loudly cry out, "Great is Diana of the Ephesians."

When one or two straight questions had been asked by responsible men, of responsible officials, it turned out that the Government had no intention of disturbing honest business relations, nor of cutting into the legitimate return in money, enjoyed by a patentee, who had disposed of his invention for his own and another's good. The town clerk at Ephesus appeased the mob and it dispersed, while in 1918 some here have sought to keep up the cry in the now deserted market place, "This our craft is in danger." The advice of the town clerk might well apply to us, "Seeing that these things cannot be spoken against, ye ought to be quiet, and do nothing rashly."

Resolution on Railroad Administration.

The Railway Business Association at its Chicago annual meeting unanimously passed a resolution regarding railroad administration. The association went on record as saying:

"The Director General in choosing as his subordinates for operation of the railways men who have passed their lives in railway service has recognized the high character and competence of the railway personnel. We have observed with pleasure their zeal in promoting for the war the success of government operation. Their achievements during 1917 and during the severities of the past winter were fine illustrations of American skill, pluck and patriotism."

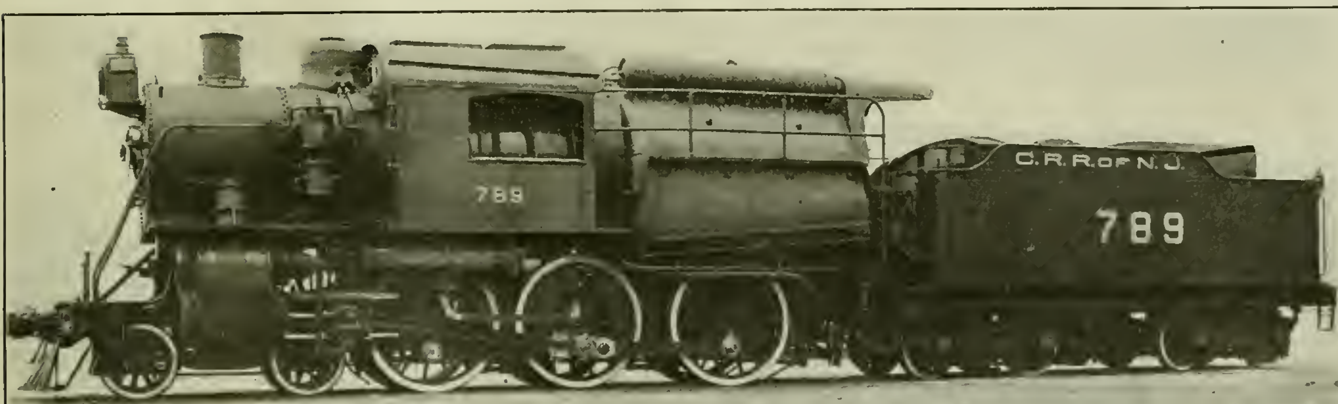
The association also resolved that, "with satisfaction we observe that the evident aim in constructing the government standard equipment designs and specifications was to admit a broad scope of interchangeable appliances. We welcome also the assurance by the Director General that the purpose is to encourage during government control the demonstration and adoption of improvements not yet established. These are policies of progress. They will tend to preserve and stimulate the industrial enterprises whose occupation it is to achieve mechanical advance in transportation science. We earnestly commend to the Director General's consideration the fact that a large proportion of these enterprises is founded upon patent rights and that an indispensable essential to preserving the enterprises themselves is to maintain unimpaired the normal status of patents. The owner of the patent who leases to a manufacturer has a contract which cannot be abrogated without his consent and which he may not be in position to abrogate. The royalties are the earnings of his genius. The enterprise which owns patents has for an asset, in some cases its chief asset, as a going business the right to protection against under bidding by concerns whose overhead cost has not included the experimentation, demonstration, development and improvement of the device."

Dumping Cars at the Track Level.

Lay a strip of canvass across the bottom of each car and up the sides. Fasten one end of the canvas to the upper edge of the car, on the side that is to descend when dumping. Fasten a heavy cleat to the other or free end of the canvas, with a ring in the cleat. After dumping the car, the dumpman hooks a rope to this ring, and the engineman winds in on the rope, which passes through the snatch-blocks and around the winch head of the engine. Whereupon, the strip of canvas is thrown back across the bottom and sides of the car ready for the next load.

Ten-Wheel Locomotives for the Central Railroad of New Jersey

In 1910 the Baldwin Locomotive Works built for the Central R. R. of New Jersey, ten locomotives of the 4-6-0 type for fast freight service. These engines used saturated steam, and developed a tractive force of 35,000 lbs. with a weight on drivers of 158,800 lbs. They proved to be a decided success, and in 1912 the company ordered ten additional locomotives of generally similar design, but equipped with superheaters. In them the steam pressure was reduced and the cylinders were enlarged, the resulting tractive force being 36,500 lbs. Ten additional superheater locomotives were ordered in 1913; and another consignment of ten, as illustrated by the accompanying picture of engine 789, has recently been placed in service. The new locomotives are closely similar to the design of 1913, but the steam pressure has been raised from 200 to 220 lbs., thus increasing the tractive force to 40,140 lbs. With 170,800 lbs. on drivers, the ratio of adhesion is 4.25, which is ample for the service.



TEN-WHEEL TYPE (4-6-0) FOR THE CENTRAL RAILROAD OF NEW JERSEY.

C. E. Chambers, S. M. P. Baldwin Loco. Works, Biulders.

During the past few years the building of ten-wheel or (4-6-0) type locomotives for main line work, has decreased; and the Pacific or 4-6-2 type has been substituted. In the present case, however, the continuation of the ten-wheeled type is fully justified. These locomotives use fine anthracite, or a mixture of anthracite and soft coal, as fuel. This is burned on a large grate in a comparatively shallow firebox, which can easily be placed above the 69-in. drivers without raising the boiler to an excessive height. There is, therefore, no necessity for using trailing wheels, and the result is a compact design of locomotive with a relatively large proportion (75 per cent.) of its total weight on the driving wheels, therefore, no trailers are used.

These locomotives have proved to be specially successful in operating the joint service, with the Philadelphia & Reading Ry., on the line between New York and Philadelphia. This is a high speed route, with moderate grades, handling a large amount of fast freight traffic, which must be kept clear of passenger trains. The ten-wheelers handle this business efficiently; while they can (should occasion require it) be temporarily transferred to passenger service.

The boilers of these locomotives are of the modified Wootten type. The design embodies a short combustion chamber, or D-head, 5 ins. in length, which serves to keep the fire out of the bottom tubes. The grate is of the rocking type, and the bars are grouped in longitudinal sections which are separated by water tubes. The finger bars are small castings, designed so that they can be used interchangeably in fireboxes of different widths. These finger bars are fitted into slots formed in the supporting or rocking bars, which rest on the grate side-frames. This construction involves the use of a large number of castings, but if a finger bar breaks there is a minimum amount of material to be replaced, and this can be done without dismantling any other part of the grate-work. The firing is done through two circular doors, whose centers are 38 ins. apart, transversely. The door opening is formed by flanging both the inside and outside sheets backward, and uniting the flanges with the sleeve.

Flexible bolts are used exclusively in the side water-legs below the boiler center line, and similar bolts stay the greater part of the throat and back-head. Three rows of expansion stays support the forward end of the crown. The flat areas of the front tube sheet and back head, above the tubes and firebox, are stayed by gusset plates. The boiler barrel consists of two rings, the first of which is tapered, increasing the shell diameter from 74 to 79¾ ins. The main dome is placed on the second ring, and the auxiliary dome, carrying the safety-valves and whistle, is over the firebox.

The steam distribution is controlled by piston valves 13 ins. in diameter, which are driven by the Walschaerts motion. The cab, in this design, is placed over the middle of the boiler, and no reach rod is required, as the vertical arm of the lifting shaft is extended to form the reverse lever. The pistons are steel castings, with follower plates of the same material, and Dunbar packing rings. The cylinder and steam chest bushings, piston and valve bull-rings and packing rings, and pedestal shoes and wedges, are of gun iron. The crossheads are each made in one piece, of cast steel, with tin lined wearing surfaces. They work in guides of the alligator type. The frames are of carbon cast steel, 5 ins. in width, each made in one piece with a single front rail.

The tender is carried on equalized pedestal trucks, and has a one-piece, cast steel frame. The tank is equipped with a water-scoop, operated by compressed air. Further particulars are given in the table of dimensions.

Gauge, 4 ft. 8½ ins.; cylinders, 23 x 28 ins.; valves, piston, 13 ins. diameter. Boiler—Type, wagon-top; diameter, 74 ins.; thickness of sheets, 13/16 and ⅞ ins.; working pressure, 220 lbs.; fuel, fine anthracite; staying, radial. Fire box—Material, steel; length, 122⅛ ins.; width, 108¼ ins.; depth, front, 64½ ins.;

depth, back, 52½ ins.; thickness of sheets, sides ⅜ ins.; back and crown tube, ⅝ ins. Water space—Front, sides and back, 4 ins. Tubes—Diameter, 5⅜ ins. and 2 ins.; material, 5⅜ ins. steel, 2 ins. iron; thickness, 5⅜ ins. No. 9 W. G., 2 ins., No. 11 W. G.; number, 5⅜ ins., 30: 2 ins., 210; length, 13 ft. 10¼ ins. Heating surface—Fire box, 211 sq. ft.; tubes, 2,095 sq. ft.; total, 2,306 sq. ft.; superheater, 477 sq. ft.; grate area, 91.4 sq. ft. Driving wheels—Diameter, outside, 69 ins.; center, 62 ins.; journals, main 11 x 12 ins.; others, 10 x 12 ins. Engine truck wheels—Diameter, front, 36 ins.; journals, 6 x 12 ins. Wheel base—Driving, 13 ft. 6 ins.; rigid, 13 ft. 6 ins.; total engine, 25 ft. 2½ ins.; total engine and tender, 56 ft. 5¼ ins. Weight—On driving wheels, 170,800 lbs.; on truck, front, 54,800 lbs.; total engine, 225,600 lbs.; total engine and tender, about 370,000 lbs. Tender—Wheels, number, 8 in all; diameter, 36 ins.; journals, 5½ ins. x 10 ins.; tank capacity, 7,500 United States gals.; fuel, 13 tons of coal; service, hauling freight trains of ample capacity.

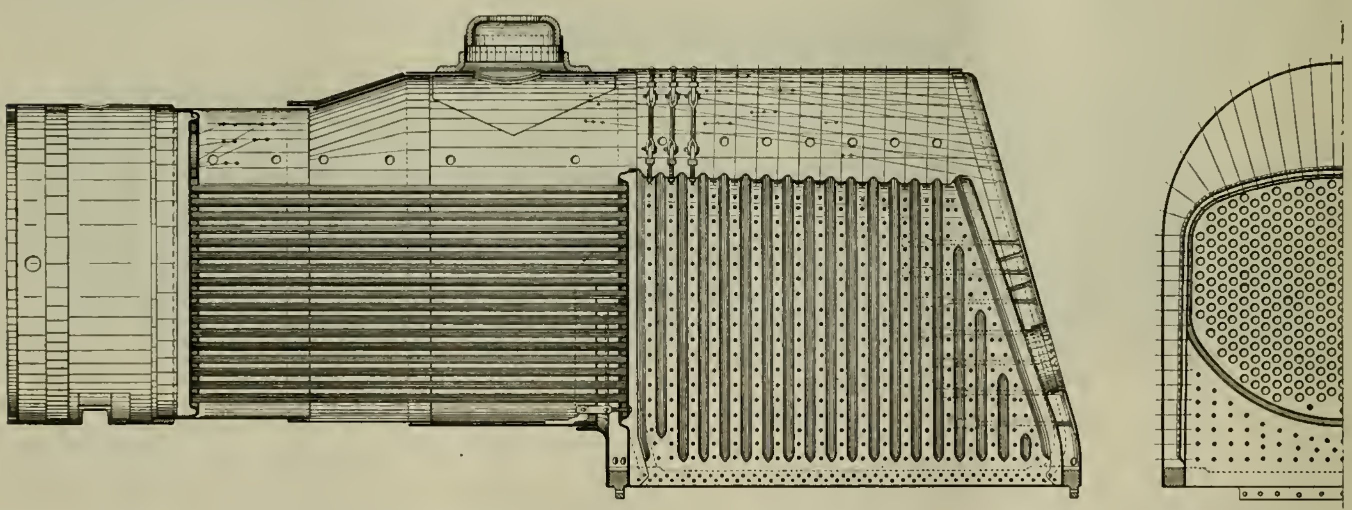
The Corrugated Firebox Sheet

The corrugating of boiler plates is not new, but the application of the principle to complete locomotive fireboxes is among the more modern attempts to strengthen the internal structure of the boiler, provide greater heating surface and save expense. When these phases of the matter are looked into, the product of the William H. Wood Locomotive Firebox and Tube Plate Company of Media, Pa., will be found to possess merits of a very substantial order and to have a number of points which are well worth looking into, as they are capable of sound mathematical backing, and in the matter of practical test, have successfully stood up to the exacting requirements of every-day service on the New York Central Railroad and on other lines. In this test they showed fuel economy and no stay-bolt breakage.

When we consider the corrugated plate, say ⅜ inch thick, made like a series of frozen waves, the crest of each wave 5 inches apart, with a depth of 1¼ inches, we find that this plate is stronger than the flat plate, by a very substantial margin. The deflection caused by a given load on a flat and a corrugated plate, does not tell the whole story. According to Mr. J. H. Bickley, one of the engineers of the Wood Firebox Company, the deflection of the flat plate loaded to 3.75 lbs. per square inch is .6557 inches, while that of the corrugated sheet loaded to 89.9 lbs. per square inch is .6421 inches. This gives the corrugated plate the advantage of .0136 inches with an excess load of 86.15 lbs. per square inch over the flat plate. Our illustration shows the section modulus of the two plates as .11717 for the flat plate, and .7967 for the corrugated plate. These figures for the section modulus are each a purely geometrical quantity, depending solely on the dimensions and shape of the section, and are independent of the material or manner of loading. These figures, like those for deflection, do not tell the whole story nor, as far as we are concerned, do not tell the important story.

The vital mathematical backing is made plain when we work out the fibre stress. The result obtained from such an operation shows that, taken at a most conservative figure, the corrugated plate, without stays, and depending wholly on its shape for stiffness, is more than seven times as strong as the flat plate. This puts the factor of safety away up, and entirely beyond controversy. One of the first facts which would immediately strike any conscientious investigator of this matter is that if, say, a crown sheet, of one type, is inherently seven times stronger than another, and generally used type, the inherently stronger plate will stand wider spacing of staybolts than the generally used type. This is exactly what is found in practice. In certain fireboxes where corrugated plates are used, many staybolts have been eliminated, and it adds 3.97 square feet to the total heating surface of the firebox and combustion chamber.

The corrugated sheet, however, has another advantage to put forward in the matter of staybolts. Those staybolts which must be put in the box, are treated in the mildest manner by the sheet with the many folds. Expansion and contraction are the two worst enemies that a staybolt has to encounter. The constant, though slight, movement of the stiff sheet bends the bolts always at the same point, and ultimate rupture is the result unless flexible bolts are used. The corrugated sheet itself moves in obedience to this law of nature, and it must move under the influence of heat and cold, but the staybolt does not now feel it as much because the folds of the corrugated sheet open and close through a minute distance, like the motion of the folds of a concertina. This movement is taken up by the folds of the sheet and does not affect the staybolt to any appreciable extent.



LOCOMOTIVE BOILER WITH WM. H. WOOD'S PATENT FIRE BOX AND TUBE PLATES

NOV 26, 1908 — WM. H. WOOD — ENGINEER — MEDIA — PENNA.

This unique method of handling the

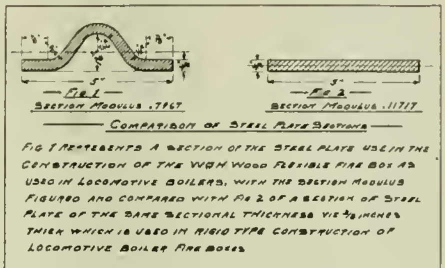
expansion and contraction strains by the corrugated plate, might also be called beneficent, and certainly it would be, if the plate knew what it was doing. It, however, brings the flues under its influence and the beading of the flues is not pulled out of position by the expansion or contraction of the firebox as its folded, concertina-like shape takes up all such movement. This incidentally leads to less beading and re-rolling of flues being performed as running repairs, and the number of leaky flues may be very materially reduced.

The corrugated plate firebox has the advantage of presenting a larger area of heat radiating surface to the water, than a flat plate can present. The folds of the sheet add very considerably to the extent of plate upon which the water rests, and within the box the area upon which the fire can play is augmented. This has a beneficial effect on the steam-producing qualities of the firebox, and at the same time, the pressure area is not rendered the least bit larger. We mean by this that if the corrugated sheet had the folds pulled out flat, it would occupy a larger area, and this larger area is what the heat can pass through to the water. The pressure area is not altered because if one square foot of sheet sustains a pressure of 200 lbs. per square inch, it does not in the least matter if the sheet is flat or arched or bent or folded. No more than 200 lbs will be sustained by the one square foot, irrespective of its shape, while heat takes advantage of any and all variations of shape to get through to the water. The corrugated plate is free for heat transference

The absence of some bolts acts to give a free circulation to the water as it is heated; by the flow of cool water to the hot plates, and this process is known as convection.

The corrugations of the sheets have incidentally another advantage. We know that the sheets with the folds, in common with the flat sheets, are amenable to the laws of nature, and one of these laws is evidenced by the results of expansion and contraction, due to heat and cold. Both kinds of sheets move in obedience to this law, but the corrugated sheet provides means to follow the law without deterious effects to itself. The flat, rigid sheet "puts up" a fight in which it must ultimately lose, or break some of its staybolts or loosen its tubes. Both kinds of sheets move, but the corrugated sheet has by what amounts a slight crumpling action a tendency to break up and shift any particles of sediment before they harden into scale. The corrugations are usually placed like solid waves, across the box, and the water surging over them is tossed about in a way to aid convection and the slight movement of the plate between the folds acts against the formation of scale and the tossing, surging water flowing over the stiffly settled "steel waves" of the crown sheet washes away the unsolidified sediment and automatically keeps the sheet clean, and in good heat-radiating condition.

This firebox itself is flexible, and any rigid connections to it such as bolts, slings, flues, or stays find themselves, like



COMPARISON OF CORRUGATED AND FLAT PLATES.

an anchor at the bottom of the sea, holding a ship firmly yet without the necessity of preventing the slight swing or heave or tide movement, which the vessel must have, while it is in the water, and which movement, being provided for by the shape and build of the boat, is both safe and legitimate.

progress in knowledge has been achieved, if they are not valid, the sooner we all know it the better. If it is possible to test this form of box, reliable data will add to the knowledge we have, if the tested box fails it is worth while to know about it. In the William H. Wood firebox the crown and inner sheets are corrugated, so that the whole box can lengthen and shorten under the influence of heat and cold without distortion of any kind taking place in the other parts of the boiler or in the staybolts or slings.

An Ancient Boiler.

People who enjoy the privilege of visiting various parts of the world sometimes meet with surprises in seeing ancient inventions that are supposed to be entirely modern.

This impression came forcibly home to the writer when he visited the Museo Borbonies in Naples, Italy. Here he found many copper and bronze tools preserved that were exhumed at Pompeii. Among the curiosities to be seen in that museum is a small vertical boiler of copper. This has a firebox and smoke flue through the top, a door on the side, and water grates composed of small tubes of copper crossing the firebox at the bottom.

Pompeii was destroyed by an eruption of Vesuvious, A. D. 79.

WOOD'S FIREBOX WITH ARCH TUBES
VS
STANDARD FIREBOX WITHOUT ARCH TUBES
COMPARATIVE TESTS.
RECAPITULATION
1909.

Our Inspector was not allowed to be in attendance while the test was being made, although permission was granted by General Superintendent Motive Power

There is a noticeable difference in boiler pressure on the respective engines during test.

Copied from New York Central prints in office of Wm H. Wood, Engineer, Media, Pa

No.	ITEM	WOOD	STANDARD	Percent Difference Increase	Percent Difference Decrease
1	Division	Western	Western		
2	Ton miles total (Train weights as per Conductors Wheel Reports)	1,233,939.00	1,113,794.00		
3	Standing time, total	14 hrs 39 min.	12 hrs 48 min	14.45	
4	Running time, total	41 hrs 13 min	36 hrs 53 min		
5	Ton miles per hour, average.	30,502.00	30,176.00		
6	Speed, miles per hour, average.	14.77	14.5		
7	Position of throttle percent of full opening, average	26.60	28.9		
8	" " reverse lever, percent of full stroke cut off, average.	41.00	39.75		
9	Boiler pressure, average.	178	192.		7.29
10	Draft, inches of water, average.	3.14	4.8	7.08	
11	Temperature in smoke box (while working) average	631.	553.	14.46	
12	Water evaporated per square foot of heating surface per hour from and at 212°F.	8.234	8.131	1.27	
13	" " " pound of combustible	9.952	9.696	2.64	
14	Pounds of coal per square foot of grate surface per hour	65.39	66.97		2.3
15	" " " " ton mile per hour	1.302	1.325		1.73
16	" " " per draw bar - horse power - hour.	6.445	6.749		3.49
17	" " " water " " " "	43.334	47.415		4.38
18	British Thermal Units per pound of dry coal (by analysis) average.	14477.	14192.	2.01	
19	Draw bar horsepower - average.	617.312	616.158	.219	
20	Boiler	906.	920.		1.52
21	Boiler efficiency, %	57.125	53.575	2.6	
22	Locomotive efficiency, %	2.902	2.695	7.77	
23	BTU per pound of water evaporated from and at 212°F	1573.3	1620.5		2.91
24	Pounds of water per pound of coal (as fired) (actual evaporation per pound coal)	7.0875	7.0125	1.01	
25	" " dry coal per square of grate surface per hour.	61.97	66.15		6.31

In the Percent Difference column the standard Engine is taken as the basis of comparison

TABLE OF TEST OF WOOD'S FIREBOX ON THE N. Y. C.

In these days when it has been most sagaciously said that America and Progress are synonymous terms, may not the powers that be, in the railroad world today, look into the advantages, scientifically backed by theory and test, which this company makes claim to. If a boiler of a locomotive can be made stronger, more efficient, and with many economies, it appears to be a good thing to study, and officially judge of the value of the claims put forward. If the claims are valid,

Will Require Year to Complete.

Though completed, there is still sufficient work in connection with the Quebec bridge to engage the attention of Lieut.-Col. C. N. Monsarrat, chairman and chief engineer of the board of engineers, for at least another year. This was announced in parliament recently by Hon. J. D. Reid, Minister of Railways and Canals, who also paid high tribute to the services rendered by Col. Monsarrat in connection with the big bridge.

Synopsis of Mr. Geo. A. Post's Address

Mr. George A. Post, the retiring president of the Railway Business Association, addressed that body at the lately held annual meeting, and said some very interesting and very important things. Space does not permit us to reproduce the speech in full, but we have endeavored to give the salient features of the address, and to call attention to what we believe to be the real intention of the government. The Director General has, through his trusted subordinate, Mr. John Skelton Williams, the director of finance and purchases, spoken with authority. Mr. Williams is also the comptroller of the currency.

The bogy of patent royalties, being unreal, has gone. In fact, it was not part of the enlightened policy of the government. It was but a figment of the imagination which readily found lodgment in the minds of those who, without investigation, feared the worst, and Mr. Post has done good service to all concerned when he asked a straight question and got an authoritative answer. The principal points brought out in Mr. Post's address are here reproduced. He took up the question, or rather he spoke of the correct attitude the supply men should adopt in the war. He said:

"There is no body of men in this country of ours whose bosoms are stirred more deeply than ours at this moment; whose contributions of every kind and nature, of money, of intelligence, of energy, are being poured forth more freely than from this craft of ours; and it will ill become anybody, anywhere, by innuendo to challenge for a moment the patriotism of the railway supply craft, just because there shall happen to be some little question about the prices of our commodities.

"We are at the forks of the road, and the question is: Shall we follow the wise path or the path without wisdom? A new order of things now obtains. We are going to do business for the next few years under conditions greatly changed from those that have hitherto prevailed. It is deeply upon my mind and conscience that we must not at this juncture heedlessly assume some attitude which may be misunderstood, whereby we may be assailed as a sullen or defiant band in our dealings with the government.

"Let us not, because of uncertainty or anxiety in this period of adjustment, become hypercritical as to the methods that are being pursued in doing business with us. There may some of them now new. There will be many of them that will be old, with which we are thoroughly acquainted; and I beg of this audience and of our craft that we shall not fall into the awful error of standing around hotel corridors hurling anathemas at the government of the United States because of some little delay on the part of a government officer in meeting an appointment with us, or of his brusque manners and inquisitiveness.

"Perhaps it might be well for us supply men to tear a leaf out of the book of experience of the railroads. You know that when the government began to think that perhaps it ought to have something to do about the regulation of the railroads, there was considerable aggravation expressed and manifested. There was a disposition to rebel. But—and I think it is the asseveration of all now—if there had been in the early stages more of a spirit of co-operation and of patient desire to explain the ins and outs of this and that, that there would have been less trouble for the railroads than ensued as the result of their attitude at that time. The facts should have been spread out in good humor, the truth told every moment of the time, and they should have acceded to the idea that perhaps in a time of agitation the right is not all on one side.

"We may find that the government, facing us for the first time in the capacity of our customer, does not know all that we know about our business; that it may have erroneous impressions in regard to the way that we do business. It does not understand how we arrive at our cost, how we figure on what we think is a proper profit upon our business adventure.

"These men who are the government officials with whom we have not heretofore dealt, must be reached by persuasion, by explanation, and if they do not get it the first time, try to have them get it the next time. Thus we shall be to the government what we have a right to be and ought to be, and that is, an esteemed body of men whose product is of prime importance to the salvation of our country. Let us show them that in this hour of peril by no act of ours will the government be gouged.

"Let us put forth always the argument, which must be maintained, and which cannot be gainsaid, that the manufacture of any product, giving employment to men and to capital, must, in the last analysis, when it has been produced and conveyed to the customer, show in the remittances made therefor, a profit which will warrant the continuance of that enterprise, that it may continue to be a unit in the great industry of our country. Nothing sadder could happen to this country than that exactions mistakenly made by the government agency itself should reduce profits until an industry becomes prostrate, its power to employ labor gone, as well as its power to make contribution liberally to all patriotic causes. Nothing worse could happen to the railroads of this country, now a department of the government, than such a weakening of industrial forces as shall minimize their output, which in turn would minimize the tonnage to be carried by the railroads, and which would reduce the earnings of the railroads. All these dangers, if we will be careful, if we will be patient, if we will be tactful and honest, can be cleared away.

"While we say the government is in control and the government is buying, go where you will all over the country, into every purchasing agency, and you will find that while the name over the door may be "Uncle Sam" it is the same old crowd inside with whom you have long been acquainted. As Mr. McAdoo said to me when I was talking with him one day, 'I have taken these railroads over as a going concern, and have hired or fired nobody.'

"We have been quite deeply stirred of late, and probably this audience sitting here is now greatly disturbed over what is known as the patent question. Rumors have flown thick and fast as to what was going to be required by the government. Wouldn't it be a great mistake for us to denounce the government, when all the trouble that we are facing today in regard to patents, comes from the active, insistent, plausible propaganda of a man now and long in the railroad supply business, a man of eminence in our craft, who openly and everywhere, without concealment on his part, has been advocating to government officials that it would be a proper thing to do and easy of accomplishment for manufacturers of patented devices to eliminate royalties as cost factors, and that we should be asked to waive our patent rights? That conception never arose or emanated from the Director General of the Railroads or from the Director of Purchases. Whatever inquiries are being made to find out whether these suggestions are as easy of accomplishment and as acceptable to us have been started by one who is an equipment manufacturer.

"I may say that no man could have received a representative of an organization like ours with greater courtesy and cordiality, and accorded more time for me to speak freely than when Secretary McAdoo gave me an audience a few weeks ago.

"Mr. McAdoo is emphatically for progress and on the question of standardization, there was nothing that I wanted to

discuss that he was not willing and eager to hear and to give full and free expression with regard to it. I asked the question of Mr. McAdoo, 'Will it, in your opinion, be necessary to adhere so rigidly to standards now to be fixed as to cause a cessation of all trial development and acceptance of new mechanical devices intended for the more economical operation of the railroads?' To which his response was, quick and emphatic: 'Why, certainly not! There never was a time in the history of our country when inventive genius should be working at high speed more than now.' And responsive further he said. 'Why, if there shall be perfected devices that are of major importance and if the men who have designed and perfected them seek an opportunity to try them out, and are not able to effectuate that through the railroad officials, I would like to have them come and see me, because progress and America are synonymous terms.'

"The Director General of Railroads, when he said that to me, as your representative, could not have had in his mind that the men of inventive genius in America should focus their minds upon the solution of problems vital to the increased usefulness of the railroads, get men to back them and spend money freely so that they might go on with the work, furnish the material and equipment wherewith to make trial and experiment, covering weeks and months, and after they have done it, after they have demonstrated that it is a desirable and important entity, that the government of the United States would turn and say, 'Thank you! There is nothing doing in the money line for you.' I do not believe any such frame of mind was his. I do not believe that so alert and practical an American as the Director General could ever have had it in his mind that he could spur on the inventive genius of the country, invite investment of large proportions upon the gamble of success in the construction of a desirable thing for railroads, without having a reward which should take the shape of revenue whereby there should be increased living comforts and accumulation for the man or men who had given their brains, time and money to evolve it.

"I have been told that the Director of Purchases, whom I had not yet had the opportunity of meeting, was an austere personality, a man who had a preconception of what he was going to do and going to compel our people to do; that to get an audience with him was an impossibility. I said to his secretary by telephone, 'I am Mr. George A. Post, president of the Railway Business Association,' and when I saw him I found him courteous, not much given to having any loose talk, wanting to get right at the point. I had a good, straightforward business interview. In the course of the conversation, I think I did touch the pulse of this situation. Having learned that at the meeting on Monday, a week ago, when the manufacturers of engine specialties were in Washington, there were many of them, closely packed into a small room, where it was impossible that there could be a satisfactory conference, I ventured to suggest that perhaps there was a better way to do than that. I said that there had been called about 140 of these men, who came to Washington, and that the meeting had been more or less futile. I said that there is soon to be called a meeting of the car specialty manufacturers, and when that call is sent out there will probably be 200 people, too great a number to get into any chamber in the Interstate Commerce Building, and too large a number to carry on anything like a conference. I ventured the suggestion that the Railway Business Association should appoint a committee of five or seven men, men of executive status, men who know, who are of high repute as production experts, men of technical skill, men of ripe business experience, accustomed to the anxieties, uncertainties and the responsibilities of business, who could, in his presence, in a room, engage him in a conversation and could answer his questions. Mr. Williams asked: 'But will this committee have power to do business, to make contracts for everybody?' I said, 'No; they will not. That can only be done by individual firms.' Mr. Williams was not able to see that the session would be one of accomplishment, nd courteously said that he did not think that would work.

"Expressing my regret, I called his attention to the point that pending the time that this committee should have had this colloquy and marshalled for him the information they could give him, there should be held in abeyance any decision or order in regard to the use of patented articles in connection with the cars and locomotives. I said, 'As long as the committee is not to come, and as long as I am here, will you permit me to briefly give you the situation?' I said. 'At the meeting on Monday last, the Purchasing Agent, who then presided over that meeting, said that in making their quotations the manufacturers would be expected or requested to eliminate royalties as a factor of cost and to waive their patent rights.' I said, 'This request or expectation or requirement, whichever it may be, is impossible of effectuation by many people. In many cases it is absolutely impracticable and legally impossible to accede to such a proposition.'

"He (Mr. Williams) said: 'The idea of taking away from the owner of the patent, or designer, the royalty that is agreed to be paid him is not what I am thinking about. Whatever you make, supposing that it is in the specifications as one of the things that may be used, then, of course, it can be used for one or 100,000 cars. Supposing that your capacity for output of this patented commodity was only a third of what the government might desire to buy, enough, say, to equip all the cars with your device. If I should buy the full capacity of your plant, and the government still wanted more than you could make, why cannot there be some arrangement made whereby you will grant the right to somebody to make that which the government needs, you having got all the business you can take care of? The inventor, the royalty man, will be deeply interested in having the government buy as many as it will.' This showed that he still had no thought but that the person who had designed, who was dependent upon the income from the royalty should be made happy rather than miserable.

"I explained to him, of course, what a patent device meant, and how its utility rested entirely upon its being properly made, dimensions accurately adhered to and the assembling done with precision; that unless all those things were done it was useless to buy it anythow because it would not function as it should, and nobody would be responsible for it when it was delivered. He said, 'Couldn't some arrangement be made whereby the article could be manufactured, beyond the capacity of your plant, by somebody who could manufacture under your supervision, making the requirement that it should be the same as you are making, and for which service you should receive pay, not as much as the profit that you get from those you are making yourself, but a fair allowance for the work that you do in having made that thing which the government believes it needs?'

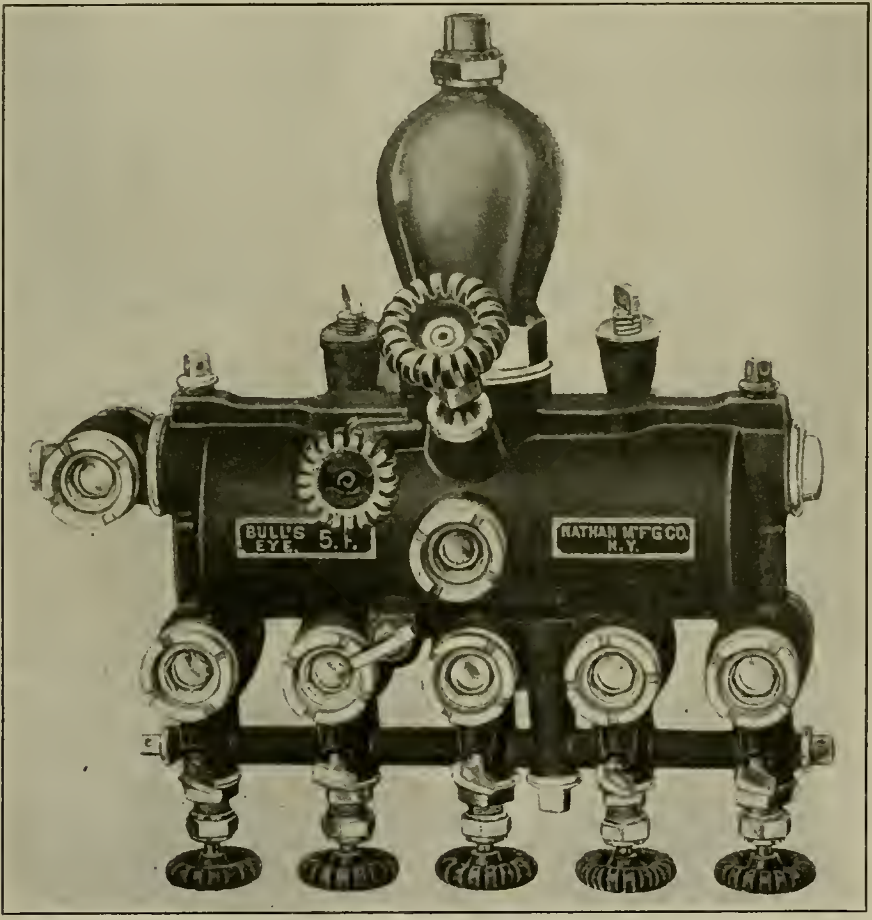
"That constitutes the whole of the interview had with the Director of Purchases. No man could ask to be received more courteously than I was, no man could ask to be given more time to state his case than I was accorded. He, perhaps, does not know all about the supply business that I and you, my associates, do. I had told him some things I think that he had not up to that time had explained to him, and from that time on he will know what those particular things are.

"Let us take this world as we have it now. It is a new world, with new and higher ideals awakened, and new methods of doing business in process of establishment. We are patriotic men, we are business men, we have brains, and we have solved many a problem before. Problems lie before us to be solved, and I will bet my bottom dollar that the railway supply craft of America has brains enough and patience enough to solve this one to our solid satisfaction, so that the government shall be well served and not overcharged, and that we shall all be happy."

Mr. Post gives an accurate outline of the utterances of the Director General of Railroads and the Director of Purchases.

Lubricators—Their Construction and Maintenance

The degree of perfection which has been attained in the construction and operation of nearly all of the lesser appliances of the modern locomotive is apt to lead to a mistaken idea that being mostly automatic in their action they do not require as much attention as appliances that may be said to depend entirely on the careful manipulation of the engineman. This idea was impressed upon us during the severe weather of last winter by learning of the bursting of a number of lubricators that had been allowed to become frozen when a little forethought could have prevented the disasters referred to. Opening the waste cock at the bottom of the lubricator, with the steam valve open, the obstruction of whatever kind will be blown out through the waste cock. The common precaution taken in dwelling houses of allowing a little water to pass through an upper faucet during intense frosts prevents much freezing of pipes. Of course, landlords have their wits sharpened in the interests of economy. The freezing of water pipes in a building is a personal loss, and it rarely happens twice to the same landlord.



NATHAN'S "BULL'S EYE" LOCOMOTIVE LUBRICATOR FIVE FEED TYPE.

Coming back to the lubricator, the constructors usually furnish directions for use. Like shop rules and other lengthy proclamations, they are not read and digested as often as they might be, and a brief recapitulation of some of the principal precautions against lubricator troubles should not be considered amiss at this time, even if the danger is less during the summer when obstructions are not so common, or are more readily solvent.

It should always be observed that in coupling a lubricator in place the steam pipe should be carefully cleaned, especially if an iron pipe. The formation of scale and chips in the inside of such pipes is continuous, and their tendency to reach the lubricator is very great where they clog up the pipes and other passages. It should also be observed that steam is taken from the highest part of the boiler. Turrets are not infrequently called upon to furnish more various openings for the delivery than they are capable of supplying. A special dry pipe for the use of the lubricator, if possible, is better practice. Pipes should be so arranged that water traps are impossible. A steady fall towards the steam chests is essential. Oil will float upwards through water, but will not float downwards. The need of straining the oil before filling it into the lubricator is also a prime necessity, as the tendency in oil to attract and retain foreign particles is very great, and these substances, of whatever kind, have a pernicious effect on the valves and openings. Not only so but some kinds of oil invariably leave a residue behind that is apt to harden and affect the working of the lubricator, hence it is good practice to immerse the lubricator in a lye bath. In the case of the choke plugs being stopped up, close the steam valve of the lubricator, and open the throttle valve of the engine. This will blow steam from the steam chest back through the choke plugs, and blow the obstruction into the sight chamber, and leave the choke passage free. In the case of the oil disappearing from the reservoir, this may be caused by the water pipe, leading from the condenser to the oil reservoir, being split or loose, or by reason of cracks developing in the passages, near the top of the oil reservoir, allowing the oil to feed directly into the delivery arms or into the condenser, and from thence into the tallow pipes, without passing visibly through the glasses. This may occur from freezing or from careless handling.

A word might be said in regard to the general underlying principle or cause of action in the lubricator. Assuming that the cylinder or chamber of the device is filled with oil, a pressure of steam forces the oil through nozzles up through a body of condensed steam in the lubricator, and the oil passing through this body of water or condensed steam, the oil can be seen through a glass bull's eye or short glass tube. The amount of oil flowing may thus be readily observed, and regulated by needle valves operating under the nozzles. While the number of nozzles may be increased, the operation in each is separate, and may be regulated according to the requirements of the moving parts to be lubricated.

As the drops of oil pass into the pipes leading towards the parts to be lubricated it mixes with the steam, and thus forms a steam lubricant, thereby reaching every part of the valve seats or cylinder walls. The device is in every way vastly superior to the older methods of lubricating by oil cups placed over the steam chests, the cups being filled at intervals by the fireman who had to traverse the distance from the cab to the steam chests or other parts. The saving in point of labor may not be very great, but the saving in the use of the lubricant is very great. Not

only so, but the lubrication is positive and readily proportional to valve and piston travel, and therefore proportioned to the work done by the locomotive, and when the locomotive stops lubrication stops. The reservoirs may be filled while in operation, and each feed, as we have already stated, can be adjusted separately, the adjustment ranging from one drop in 10 strokes to 20 drops in one stroke. The adjustment once made remains accurate under all conditions, and engine efficiency increased, with fuel and water consumption decreased.

It may be noted in this connection the mileage per pint of oil will vary from 70 to 150, depending on type, power and speed of locomotive, steam pressure and temperature, grade of track and other causes, among which may be mentioned the fact that in bad water districts the oil allowance is necessarily increased sometimes as high as 25 per cent. It may be added that no difficulty has been experienced in the lubrication of locomotives having superheater appliances. A superior quality of oil has been introduced, and the fastest superheated locomotive in the world is lubricated by an automatic force feed system. It might be imagined that the dryness and high pressure of the steam might have a deterrent effect on the steady flow of the lubricant, but the principle of operation remains undisturbed because the column of water under boiler pressure forces the oil floating on top of it into the cylinder oil pipes leading to the bearing surfaces. The difference in pressure which forces the oil is equivalent to the weight of a column of water equal in height to the difference in levels of lubricator outlet and bottom of choke plug, less the friction in the pipe, plus the difference between the boiler and the steam chest pressure.

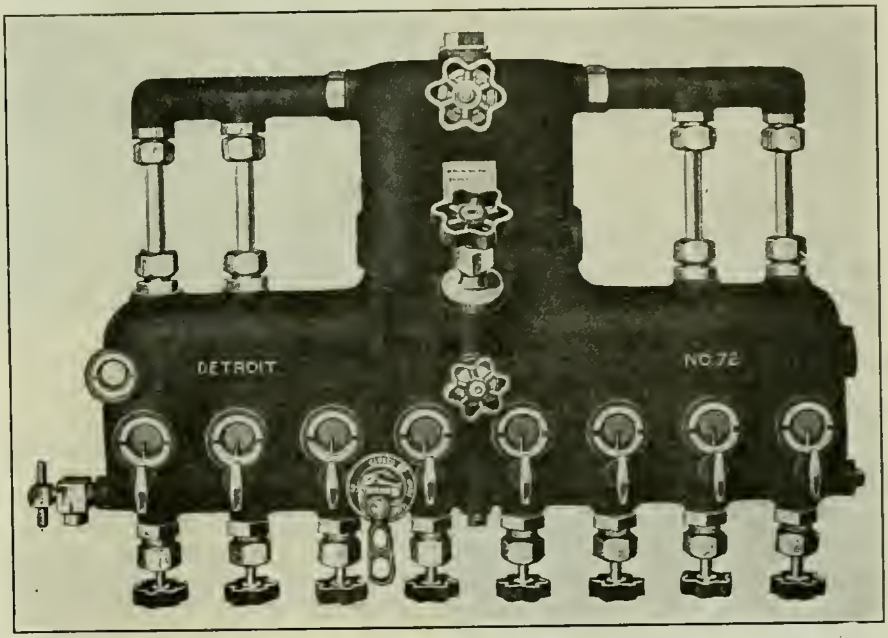
In regard to what are known as force feed lubricators, they were in service on European railways for several years, but did not appeal to American engineers, especially on account of the increased consumption of oil due to the difficulty of adjusting the feed. The improved American system of force feed lubrication applies the motion from some part of the valve mechanism, the motion of which is proportional to the valve itself, and is transmitted to the lubricator, and operates individual pumps that force the oil through pipes to the bearings to be lubricated, the speed of the plungers being thus regulated by the travel of the valve.

As may be expected, many improvements have been made on the lubricator since its original appearance. Manufacturers vie with each other in keeping pace with increasing boiler capacity and steam pressure, as well as with the increasing number of parts to which the lubricator may be applied. Among the more recent variations in form and improvement in design the Nathan Manufacturing Company have added the "Bull's Eye" pattern, which, since its introduction, has met with much popular success. This is owing to the fact that while retaining all the excellent qualities of the previous types of lubricators, the firm has substituted for the older form of tubular glasses a new form of disc glass, which will not break under any condition of service, thus eliminating all danger to enginemen, as well as delays to trains, resulting from the breaking of glass. Its introduction also makes for the simplifying of the design in other directions. This type of lubricators is also fitted with gauge glasses to indicate when the reservoir is nearly empty. All glasses are packed in casings, which screw into the body, making their removal for inspection or repairs very convenient. Fig. 1 shows the Nathan "Bull's Eye" type of lubricator with five feeds. As will be observed it has no supporting arms or other accessories to shake loose, but is of a compact and substantial form, and is meeting the requirements of the high-powered modern locomotive service with a degree of reliability that would be difficult to surpass.

Among others the Detroit Lubricator Co. has also achieved an enviable reputation, making numerous developments and improvements during the last forty years that are adapted to every type of locomotive. Among some of the company's improvements is the introduction of an oil valve in the oil passage between the reservoir and the sight feed regulating valves in the Detroit Bull's Eye lubricator. This places in the hands of the operator a means of instantly starting, stopping or throttling the rate of feed, and does away with the necessity of shutting off the feed regulation valves at a terminal or refilling on the road and consequently the necessity of opening and readjusting these valves after refilling or at the commencement of a service movement.

This oil control valve has a lever handle and index plate, and is so designed that from the "closed" position a half turn to the "all open" position will open all feeds, or a quarter turn the feed to the air pump only, and vice versa. The duty of the air pump is so severe that it requires almost constant lubrication from the time it leaves a terminal to its return to the roundhouse. It is, therefore, of importance that the air pump feed be left working while the locomotive is temporarily at rest at a station or on a siding. A quarter turn of the oil control valve handle provides for this. In this connection it may be stated that when the feeds are choked at the lubricator instead of at the steam chest two types of lubrication chokes are used. The ball choke, consisting of a movable ball adapted for closing or opening the passage way, is adapted to all lubricators where the feeds so fitted are used for lubricating the air pump. The brass choke, consisting of a short, double-seated, sliding appliance, is fitted to certain types of lubricators, and used for balancing feeds for valve and cylinder lubrication. It may also be applied to lubricators where other than air pump feeds are to be choked.

Our illustration Fig. 2 shows a front view of the light-feed standard Detroit bull's-eye locomotive lubricator containing several important improvements, and adapted for separate airbrake pump feeds and other similar forms of service.



DETROIT BULLSEYE LOCOMOTIVE LUBRICATOR SEVEN FEED STANDARD.

Economy in Psychophysical Movements

We are able to present to our readers, through the courtesy of the Franklin Railway Supply Company, Inc., some psychophysical aspects of the Ragonnet reverse gear, as applied to locomotives, and these aspects are most strikingly contrasted with the motions of a man who puts his foot against the steady-pin, and pulls a long reverse lever over from forward to backward motion. The word we have used, psychophysical, simply means the combined action of the mind and the body or as it is often more aptly phrased, to work "with brain and hand."

In the case before us, a man is "harnessed" up with wires and small electric bulbs on his wrists, ankles, etc., and he is then photographed against a dark background, the lights being arranged so that they do not illuminate his body, and the result is that we get a line of light showing his movement, reduced to its lowest terms, or in skeleton form, the pauses being indicated by bulbous "bags" of light and the rapid movements by thin undulating lines of light. A glance at our illustrations reveals the fact that the bodily movements necessary to manipulate the Ragonnet gear are smaller, more compact, and simpler than for the other old-time hand-operated gear. In it, on the other hand, where the man performs the reversing of an engine in the usual way, foot, body, arms and hands are all called into play and long lines of powerful action are shown which contrast clearly with the "finger and thumb" motion required by the Ragonnet gear.

MOVEMENTS OF MAN WITH REVERSE LEVER. HEAD, ARMS AND FEET, ALL MOVE THROUGH LONG DISTANCES.

In all these motions, whether either gear is employed, they must be made up of actions in which the mind directs and the hand performs; and the nearer we approach to reflex action, the nearer we come to animal automatism, and nearly perfect automatism would be labor with the very minimum of fatigue. One of the most common "reflexes" is the winking of the eyelid on the approach of a hostile fist, and this is performed without appreciable fatigue. The actions required in any kind of work when analyzed, require, search, finding, selecting, grasp, use, release, transport of the empty hands and waiting. Search is the putting forth of the hand; finding is the approach or apprehension of the handle; selecting is the definite location of the handle; grasp is the tightening of the hand to hold, and avoid slip; position is holding the hand so it may act; use is the movement of the handle; release is letting go when the work has been done, and transport of the hand is simply withdrawing it, after use, for rest or other employment, and if no unnecessary movements have been introduced, fatigue is at its lowest; rest is the pause before another operation is begun.

ENGINEMAN AS HE SITS IN CAB WITH LARGE REVERSE LEVER.

It is fair to say that these lines of light which are shown in the illustrations, give one a good idea of the psychophysical value of the old way and the new. They show as clearly the superiority in point of speed, muscular exertion, and brain work of the "finger and thumb" apparatus over the heavy, long, lever-pull, as would be apparent in sweeping into a dust pan, the contents of a can of green peas fallen and scattered on the floor, which is manifestly much more expeditious than separately picking up by hand each little round edible globule.

Another feature appears prominently when the Ragonnet and the reverse lever action is carefully studied. The Ragonnet gear calls into play the finer, more active, and more readily trained muscles, while the reverse lever calls upon the larger and more powerful and, one may say, more clumsy muscles of the body. This difference in apparatus represents a distinct gain in several ways such as time, bodily fatigue and thought. One of the well-known psychologists of today who conducted many interestinfi and instructive experiments; to the interpretation of which he gave much incisive analytical study, says: "Labor with the large muscles has, for psychophysical reasons never been easily combined with the subtler training of the finer muscles. Hence a social organization which obliged the men to give their energy to war and the hunt, both, in primitive life, functions of the strongest muscles, made it necessary for the domestic activities, which are essentially functions of the small muscles, to be carried out by women. The whole history of the machine demonstrates the economic tendency to make activities de-

MOVEMENTS OF ENGINEMAN WITH RAGONNET GEAR. NOTE THE FEET AND HEAD ARE STILL. HANDS MOVE ONLY.

pend upon those muscles which presuppose the smallest psychophysical effort."

A time-study of the Ragonnet gear revealed the fact that a locomotive could be reversed in four seconds, while the reverse lever took about 10 seconds to pull over. This may not sound very much or look like a substantial gain, but it is a decided and desirable advantage all round. Few people form any reliable conception of time unless they witness the movement of a material body, like the progress of the hands of a clock, or hear the rhythmic tick of a metronome. Locke, writing on the "Human Understanding," says time is "Duration set forth by measures." Piazzi Smith, at one time astronomer royal for Scotland, points out in his greatest work that "in the broadest sense time is said to be measured by the movement of some body progressing at an equable rate." It is for these reasons that clocks were invented. The object being to drive and mechanically regulate the rate of progression of the hands over the face of the clock. Time absolutely by itself is not properly conceived of by multitudes of people. There are 60 minutes in the hour, 24 hours in the day, 7 days in the week. There are therefore 1,440 minutes in the day and 10,080 minutes in the week. Obviously one minute is a very small quantity of time compared with a whole week. Indeed, our forefathers considered it small as compared with one hour, and called it "one minute," meaning a very tiny or minute fraction—namely, one sixtieth of an hour. When they came to require still smaller sub-divisions of time, they divided each minute into 60 still smaller parts, which in Queen Elizabeth's days (1559-1603) they called "second minutes" (that is small quantities of the second order of minuteness.) Now-a-days, when we speak of these small quantities of the second order of smallness, we say they are "seconds." But few people know why they are so called or how really minute they are.

Instances have been noted where people in the New York subway have looked wearily out of the windows at a station and have felt as if time had been allowed to drag on into a long and tiresome wait. The actual time measured by a stop-watch, was from 7 to 10 seconds during non-rush hours, though it seemed to be half an hour to the impatient passenger. A witness at a trial recently mistook 17 seconds for a minute and was thunderstruck when informed of his misjudgment by the court.

It is tolerably clear by this time and movement study of the Ragonnet reverse gear, that it is decidedly superior to the old hand reverse gear. Its superiority does not rest on hearsay or preference or the subtle influence of the pleasing personality of a salesman, nor the wish to have it succeed, which may be in the mind of the buyer. The study before us is the work of unimpassioned, unenthusiastic science laying bare the truth with the same cold impartiality that it would record a failure. The gain in time is there to be seen, in the "finger and thumb" gear. The minimizing of fatigue though not glaringly apparent, exists in some form, and is here reduced so that its cumulative effects are satisfactorily staved off or put back so far that they may not seriously impede the work even on a switching engine. The bringing down of the necessary mental effort tends to approximate to automatic action, with its ready hand training, and this study shows us that at least one step forward has been taken toward the theoretical goal of effortless work. Independent of any talking points or selling qualities in the gear or any improvements that may appeal to a prospective purchaser, the railroad world has been afforded a sight of a "close up" (as the movie people say) of a scientific piece of apparatus which does its work quicker, with less effort, mental and physical, than the hand gear did it, and has introduced into railway work a product which represents careful thought, correct application and satisfactory performance, and where scientific progress does what it always endeavors to do; makes work into play and looks toward swift and easy directness, to take the place of laborious exertion and comparatively slow movement. It acts promptly and scores.

Giving All a Chance.

It seems that a part of the standardization scheme broached by the government is one of dimensions and not one of particular appliances. The dictionary meaning of standard, that applies to us of the railway world, is practically that which is set up as a unit of reference, a form, a type, an example, an instance, or combination of conditions that is deemed to be correct. In this there is no hint of selecting one thing and using it exclusively. As an example, a hat without a brim would hardly be considered as the standard hat in this country. The fact that the brim is standard does not prevent any desired variety of size or shape. Applying this reasoning to mechanical devices and taking the car-coupler as a type, the only thing really standard about it is its contour and a few dimensions chosen to insure interchange and a fit.

If all injectors were made so that the bolts that would hold one class of injector would also hold any other make, the standardization here would not be oppressive, because it would permit a maker to put into his product, his own invention or any acquired patents, or his scheme for the saving of metal, or his ideas of efficiency, and in fact he could introduce things he hopes to sell it by. These might all be incorporated, and exclusively his own, if only he made his product to take the place of another similar article. This not only saves time in changing one for the other, it facilitates repairs. It is enlightened common sense, and it should afford a maker some degree of satisfaction to know that his product was received with favor because it was an excellent piece of work and an evidence of applied knowledge, and did not, and could not, appeal to railway men for the fatuous reason that the bolt holes were exactly 7-inch centres, and not something else. The government by this action would merely compel men to do what they could have done years ago, and in some instances (like the air brake) they have already done.

In railway matters, the acts of Congress, the Sherman and the Clayton laws have certainly produced effects, but the very things these enactments sought to prevent may, in a sense, come about by a sort of backward electrical surge, produced by a powerful discharge. Car builders usually employ cheap labor, and in large quantities. One of the larger concerns might, if it chose, by the offer at an exceedingly low price, practically eliminate competition.

This might be done, perhaps without sinister intent. The larger concern, with huge plant, extensive capital, and practically unlimited resources, might not, for the time being, feel the effects of an almost unremunerative contract. In the case, as it is today, where all former customers have been merged into one, and that one prepared to take maximum output from perhaps twenty concerns, a price which would represent a living wage, and in some cases, only a slender profit, would seem at least to be equitable. Under the circumstances such as now exist it may look unseemly for the lowest price to emanate from the largest concern. Manufacturers ought to be able to show that monopoly is far from their intention or desire, yet, on the other hand, cut-throat competition is as repugnant to them as is the other extreme. It is not the policy of the government to permit the destruction of competition, however, or that any solvent concern shall be forced to the wall. In times like these, patriotism is not enhanced by the stifling of commercial life at home, when at any moment exigencies in the field may demand the very maximum national output. At the moment when as on a warship, "all the ammunition hoists should be working," it is not a good time to inspect and rig up machinery that has been forced to rust in premature idleness. It seems but wisdom for the strong and powerful to hold, as it were, the umbrella over smaller and more limited concerns, until the sky clears, and the government, we may well believe, will not welcome an offer when it but gives satisfaction to a few, while it does not increase national efficiency upon which such grave issues are now depending.

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Union of Associations.

An idea, which has long lain dormant, has been brought to the fore by the Director General of Railroads. It is the amalgamation of the various railroad societies into one. In conformity with the wishes of the Director General, the American Railway Association has communicated with the mechanical and allied associations. The replies received from these bodies are not yet definite enough to constitute any pertinent suggestion upon which those having the matter in hand can act.

The joint meeting of the executive committees of the A. R. M. M. A. and the M. C. B. associations was called by instructions from the Director General of Railroads to make arrangements for the future work of the associations, and, as the letter from the American Railway Association, pursuant of this idea, points out, "That the form of organization of 'Congress of Associations' to meet the desire of the Director General for an amalgamation of the various associations is to provide one organization to make authoritative recommendations to him."

The opinion of the president of American Railway Master Mechanics' Association, Mr. William Schlafge, is favorable to the idea of amalgamation. In replying to the American Railway Association, he says, among other things, when writing as the mouthpiece of the executive committee, which recently met in Chicago: "It is the unanimous opinion that the formation of a 'congress' as outlined is the desirable procedure. This association would constitute under this plan a fully organized section, covering the field of its present activities as outlined in Article II of its constitution."

It appears to us to be quite feasible, the formation of one large society in which several sections could all operate independently and yet be bound together by a governing board of the whole. This kind of society is exemplified by the American Association for the Advancement of Science, or the British Association, or the association of electrical men. These societies have each several diverse sections. The American Association for the Advancement of Science has a president and twelve vice-presidents. Each of the vice-presidents is the presiding officer of one section, and each section has its own secretary.

The sections which might be gathered together under such a name as perhaps the American Railway Mechanical Associations might include the Master Mechanics, the M. C. B., the Mechanical Engineers, the Air Brake men, the General Foremen, the Railway Electric men, the Chief Car Inspectors, the Car Foremen, the Blacksmiths, the Boilermakers, the Fuel Department men, the Car and Locomotive Painters, and the Traveling Engineers. Each one of these thirteen groups has now a society of its own, and these could be brought together, each with a vice-president of the larger society as its chief officer, and its own individual secretary, like those of the American Association for the Advancement of Science. If this was done, the new Railway Mechanical Association would not only discuss and report upon good practice, it would then have the machinery with the American Railway Association to make its views effective.

Substantial Small Economies.

These are the days of economy, that word generally refers to small savings, and in designing machines it includes the simplification of parts. It must not be confused with economics, which is one of the branches of political economy. Economics as a science deals with the production and distribution of wealth and takes no particular note of individual small savings effected in the use of commodities.

It is, however, with small economies that we are all interested nowadays. One of the commodities that certainly call for reduction is an imponderable quantity; it is human labor. It has been definitely determined by laboratory experiments, that men do not work at an even rate, that is periods of the day each has its appropriate rate at which work is done. This is as true of mental activity as it is of physical exertion.

As an example, take a man on a switch engine. There is a great deal of "reversing" to be done in the day's work. With the hand reverse gear this work is usually performed by the use of the larger muscles of arms, trunk and legs. These muscles are less readily trained than those of the hands. A man at 7:00 a. m. is fresh and presumably on good terms with himself. He reverses the engine quickly and readily in response to a signal. As time wears on, though the will is as strong and probably as alert as ever, a slight slackening in the swiftness and power in the work of the arms, may be noticed. Then comes relief and the dinner hour. One o'clock finds the man almost, though not quite, as fresh as in the morning, and work proceeds, rapidly and strongly. As 4 or 5 o'clock approaches the slackening is again in evidence, and by 6 o'clock, definite fatigue may begin to impede the work.

In all this and subtly enhancing the feeling of fatigue, is the monotony of the work. This monotony, as mathematicians would say, is a product of time and repetition. The work of "horsing her over" is laborious at any time and its repetition is not of itself pleasing. Just here the Ragonnet reverse gear comes in and fills a long-felt want.

An account of this feature appears in another column. This gear enables a man to make the cut-off of the valve advance or recede by almost infinitesmal degrees. The old-style hand gear has definite and well defined spaces on the quadrant like steps on a stairway, while the Ragonnet gear is more like the "slide" of an inclined plane. To alter the simile the old-fashioned hand gear may be likened to the half-tone spaces of the diatonic scale in music, while the Ragonnet gear may be said to have smaller divisions than even those of the chromatic scale. It has the difference in "shading" quality which exists between a cornet with valves, and the larger range of a slide trombone.

In this newer, air-operated reverse gear, a distinct gain in bodily exertion largely eliminates fatigue, and a gain in time is the result. The man is practically as good at 6 p. m. as he was at 7 a. m., and the gradual slowing down before dinner and previous to quitting time is not apparent. The man's performance is even, and there is no reason why fluctuations should appear. Conserving a worker's time and reducing his bodily exertion are things which make for small savings, cumulative in their good effects, which are real and substantial economies.

Six Decimals and an Assumption.

The story is told of a witness in court, called by the defense, to uphold the build-

ing of a stone wall. He gave his evidence clearly and without confusion. He said the wall had been carefully built by experienced and competent men. It had been put up in a good season and the stones properly fitted and the mortar was just as it should be. In fact, one would almost have believed that he had inspected every stone of it. The wall was excellent and nothing could be better. "But," said the counsel for the plaintiff, "you admit that the wall fell down. It is gone, and no explanation of its fine qualities will overturn that fact."

A short time ago an accident occurred on one of our prominent railway lines by which the engineman and three others were killed. The derailment is said to have occurred at a defective switch. A freight train had been able to pass over the switch, previously, and it was then thought to be somewhat out of order. The belief, however, prevailed that the signals protected the road and would give sufficient warning to prevent anything going wrong with following trains. The press dispatch reads: "According to the testimony of railroad men, the crew of a freight train which passed over the switch a few hours before the accident found it could not be locked. A series of block signals, however, was believed to be sufficient to guard trains following from the danger of running over the switch at too high a rate of speed, and two other trains did pass the switch before the special, without any difficulty. The wreck is believed to have been due to the engineer, who was killed, running past a signal to slow down."

It is quite probable that the signals did all that was expected of them. We are not trying to rehearse the incidents of the unfortunate occurrence and we do not vouch for the accuracy nor for the sequence of events, as stated in the daily prints. We are concerned with the fact that is glaringly obvious, that is, the signal system did not fail, it was in good working order and that it gave the full and adequate warning that it was expected to give. It did its part most satisfactorily and yet the accident happened. It is alleged that the engineman ran past the signal or disregarded the warning. The engineman is dead and cannot admit or deny the allegation. But the accident is there with all its baleful consequences. The fact, if it be a fact, that the dead engineman did transgress, affords small comfort to the traveling public and it brings home to everybody, exactly what is the function of the signal system, and what it is expectetd to accomplish.

The signal system affords a clear, unequivocal warning, but it does not, nor is it expected to, control the train. That is the fundamental point and it emphasizes the fact that a control system is now in order. This does not discredit the signal systems of the country. They are carefully thought out, they are well made, they work excellently, but they do not control the movement, nor the speed, nor the stopping of the train. That is an attribute of railway signaling work that is not here yet, and every day the necessity for it becomes more and more apparent. The whole signal system is a monument of skill, of efficiency, and of well-directed labor. But the time in which we live, requires more. A control signal is urgently needed. The demand is imperative.

Have you ever thought that forgetting to post a letter for your wife is no more of a sin than many enginemen commit, viewed simply as an intellectual lapse? Nothing happens to you, but the engineman kills someone. The consequences have nothing to do with the lapse. All "forgets" are psychologically equal. The fact that the engineman sacrifices himself to death proves he is in the grasp of something he cannot resist. To assume that one can discipline a man so that he shall never make a mental mistake or be guilty of a mental lapse again after he has made one, is to run in the face of ascertained knowledge.

Suppose you want the length of the shadow of a factory chimney at noon. You take the angle with the horizontal made by the sun over the chimney top at 12 o'clock. You do this with a sextant and get it right. You know the angle at the base of the chimney on the ground line is 90 degs., but you assume the height of the chimney. You solve the triangle and carry the work out to six places of decimals. Your mathematics are absolutelty right and your result beyond question; yet you can't swear to the length of the shadow, even when worked out to six decimal places—because you assumed one factor, the height of the chimney which you did not know.

The signal system may be worked out to six decimals one may say, and the mathematics and the functions are correct, yet it occasionally fails on account of an assumption, and the assumption is that a man is always up to 100 per cent efficiency, when it is known, and it has been proved time and time again, that he is not always up to, and sometimes not near that mark. The weak spot in the whole signal system that we use today, with its excellent mechanical accuracy, is the man, and the false assumption made about him. He now and then disastrously fails.

Boiler Efficiency.

Few locomotives evaporate more than six pounds of water to each pound of coal consumed in the furnaces; the most efficient compound, stationary or marine engines, with the best design of boiler, very rarely evaporate more than 10 pounds of water to the pound of coal. These are undeniable facts, yet accounts of boiler efficiency are sometimes published that display gross ignorance or a desire to deceive. When a new type of boiler is offered to steam users, extraordinary claims are frequently made concerning the performance. A case is cited of a new furnace abroad, which, it is said, evaporated 36 pounds of water per pound of coal, and another gentleman (a professor, be it noted) says that an ordinary boiler furnace evaporated 26 pounds of water per pound of coal. The improved furnace was one-third better than the common one, while the latter got twice as much energy out of a pound of coal as there was in it. People who say that engineering is not advancing will have to revise their statements.

The Air Brake Association.

Our report of the convention of the Air Brake Association, though necessarily condensed, will, we are assured, prove, if proof be necessary, that meetings of this association are indispensable. A complete mastery of the details of the air brake and the constant development of marked improvements in its construction and application is so engrossing an occupation that periodical exchanges of opinions among the leading men engaged in this sphere of mental and mechanical activity becomes a prime necessity. Not only so, but in the well-chosen phraseology of one of the committees, that never in the history of the world has there been a time when it was so vitally essential that the best operating conditions prevail as right now. Now when it is so highly important that all possible despatch be given to munitions of war, foodstuffs, clothing or any commodity consigned to "our boys" who have given up all that was near and dear to them at home and have gone into foreign lands to fight, and if need be die, to deliver the world from an autocracy that would be equivalent to slavery itself, and those of us who have been left at home can do our "bit" in no better way than by seeing that the cars laden with anything for the American soldiers and their allies to eat, wear or shoot out of existence the element that would destroy democracy and engulf the world in slavery, are given the best movement possible and such movement cannot be complete without the air brake and it maintained in the proper operating condition and manipulated in the proper manner.

Removal.

Owing to the need of larger facilities for the rapidly expanding business, the United States Metallic Packing Company have moved the main offices to 221 North Thirteenth street, Philadelphia, Pa.

Air Brake Department

Twenty-fifth Annual Convention of the Air Brake Association—Reports of Committees and Individual Papers

The twenty-fifth annual convention of the Air Brake Association was held at the Hotel Winton, Cleveland, Ohio, during May 7, 8 and 9. I. H. Weaver, president, delivered the opening address, followed by D. R. MacBain, superintendent of motive power of the New York Central, and by Grand Chief Warren S. Stone of the Brotherhood of Locomotive Engineers, and Walter V. Turner, Westinghouse Air Brake Company. The addresses were all of an intensely patriotic kind, and reflected in an impressively eminent degree the earnestness of the members in the important work in which they are engaged, and the general results of the work of the association is the best proof of the need of a continuance of the opportunity of meeting for an exchange of views on the vital questions affecting the improvement in the details of the air brake which is so important a factor in railroad transportation.

The secretary and treasurer's reports showed that the affairs of the society are in a very satisfactory condition. Sixteen of the members are now in the National Army Service, but the entire membership of nearly one thousand may be said to be devoting their unreserved energies and experience in the servic of the National Government. It was also gratifying to observe that the members have the good sense to keep the expenses of the society well within the income, a balance of about $3,000 being in hand, $1,000 of which was invested in war savings certificates.

The first paper submitted on a technical subject was one continued from last year. G. H. Wood, chairman, associated with H. L. Sandhas, M. E. Hamilton, Mark Purcell, H. F. Wood, L. S. Ayer, T. F. Lyons, S. D. Streeter, M. S. Beek, W. J. Hatch, C. H. Rawlin, J. A. Burke, R. C. Burns and William Spence. The subject treated was entitled as follows:

Slack Action in Long Passenger Trains.

As is well known unsatisfactory handling prevails by enginemen of experience as well as by inexperienced men. In cases where trains are poorly handled, the same train was at other times handled well by the same engineman over the same route indicating that good handling was possible. This shows that some enginemen gradually grow lax in the matter of train handling, with the result that conditions change. The committee recommended constant instruction and supervision, and also pointed out that unsatisfactory handling occurred owing to slack action in starting trains. This is caused by a change in velocity between the various cars composing the train, the degree or severity of such slack action, depending upon the rate at which the change of velocity takes place, and the weight and number of cars involved.

The report pointed out that the pernicious effects of slack action were caused chiefly by: shutting off the engine throttle and applying the engine and train brakes somewhat heavily; by applying the engine brakes and then the train brakes;

I. H. WEAVER, PRESIDENT AIR BRAKE ASSOCIATION 1917-18.

trains with brake conditions that produce effective braking power on the engine and head cars in advance of the rear cars; cars in a train having a lower percentage of braking power to their total weight than the balance of cars, which may be due to their being loaded in one case and empty in another; and inability to produce a low-brake cylinder pressure in the beginning of a brake application. Admitting all the conditions to exist, with the exception of the ability to obtain a low brake cylinder pressure at the beginning of a brake application, if the engineer so manipulates the brake that light brake cylinder pressure will be obtained when the brake application is first started, it is possible to so control the brake that it will be applied slowly until the slack has adjusted itself, and no change in brake equipment would be necessary, even if the other features mentioned above existed in a train. On the other hand, it is impossible for the engineer to control the brake cylinder pressure in the beginning of the brake application if the other features referred to are not modified to a controllable condition.

Referring to the question of building up the braking slowly to accomplish a smooth stop: Where heavy brake applications produce unsatisfactory results, it is the practice to slightly increase the time in which the stop is made by graduating the brake or through light reductions when the application is first started, and instead of attempting to stop in thirty-five to forty-five seconds, the time is increased to sixty seconds. This increase of a few seconds provides ample time to avoid any noticeable slack action.

The report also pointed out that a form of foundation brake gear can be employed, which will permit of a longer piston travel being maintained than is common. This could be depended upon, if equipped with automatic slack adjusters, to maintain the piston travel as designed, that is for 8 ins., without greatly increasing the piston travel during brake applications when the train is running, thus insuring a low brake pressure in the beginning of brake applications, regardless of the train's speed. With the single shoe type of foundation brake gear, now in common use, considerable false piston travel exists; that is, when the car is standing, the piston travel may be 5 ins. with 60 lbs. in the brake cylinder. When the car is running at a high rate of speed, 60 lbs. brake cylinder pressure increases the piston travel to 8 ins.; however, at low speeds, the same cylinder pressure will not force the piston out to the same extent as occurs at a high rate of speed, consequently, the cylinder volumes for low rates of speds are very small compared to the auxiliary reservoir. Hence it is necessary that a predetermined brake cylinder pressure be decided on for making piston travel adjustment; that is, the cylinder pressure should be that at which the slack adjuster operates, if employed, or the maximum pressure obtained under full cylinder pressures when the train is running.

The rate of retardation for service braking should be automatically fixed so that any movement of slack occurring will take place sufficiently slow as not to be noticeable in the form of shocks.

The effect of slack action is aggravated by excessive slack in draft gears; excessive unequal braking power between various cars; great differences in weight of cars; increasing the number of cars per train; unequal piston travel; proportion of auxiliary reservoir and brake cylinder volumes; time element between the movement of various triple valves throughout a train; rate of producing brake cylinder pressure; differences in rate of retardation between various cars in a train; and the requirements of service in different localities.

The report closed by emphasizing the need of enginemen being instructed that they may understand the principles and purposes of the equipment they are handling, and thereby giving a full opportunity for rendering the service of which it is capable, and which is in some details capable of further improvement.

What Is the Safe Life of an Air Brake Hose?

The committee on the above subject consisted of the following: M. E. Hamilton, chairman; George W. Noland, Joseph W. Walker and M. S. Belk. They reported that 28½ months was the average safe life of an air brake shoe. The committee had obtained records of 25,000 air hose in service. These were inspected in five different groups, and over 18 per cent were found porous. The committee had no means of discovering how long a hose had been in a porous condition before it was found by inspection, but the average life of the porous hose is nearly the same as the average life of the burst hose, so that the period of service considered safe was emphasized by the general average of hose bursting and becoming porous being nearly alike.

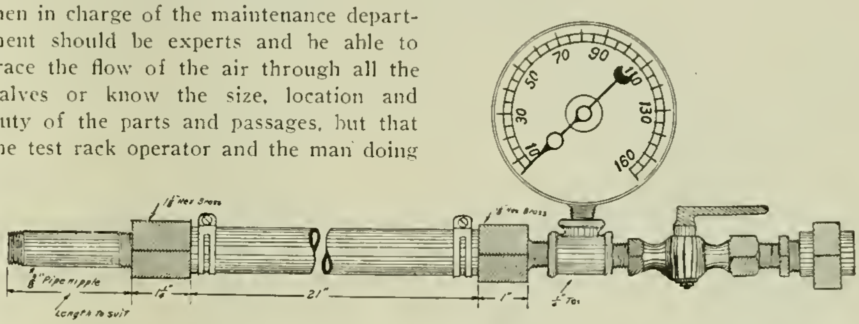
Of the detrimental effect of porous hose, the committee caused five trains to be tested for leakage, inspected for porous hose, and again tested for leakage after the porous hose had been removed. The train in each case consisted of 65 cars, and therefore represented 130 hose, exclusive of those between the engine and tender. The number of hose found to be porous ran from a minimum of 5 to a maximum of 8 on each train, or an average of 4.85. The leakage per minute before testing was from 12 lbs. to 20 lbs., and the leakage per minute after the porous hose had been removed was from 6 lbs. to 8 lbs. per minute. When it is borne in mind that the average in all hose inspected was as high as 18 per cent, it can be realized the handicap under which enginemen are working under the present average conditions. The committee recommended that the various railroad companies put into effect a system of inspection and soap suds tests, at least on repair tracks for the purpose of detecting and removing from service all porous hose. Instances were given where such a system had been established, and while it was found that the percentage of porous hose ran very high at the beginning, it gradually lessened until within two months it was reduced to such a point that only 2 per cent of the hose tested were found porous. It was also found that outbound terminal air brake delays decreased. Recommendations were also made that the railway companies insist on procuring a guaranteed hose from the manufacturers, or take up the use of properly constructed braided hose. These items will slightly increase the first cost of hose, but reduce the ultimate cost.

The Best Methods of Preparing Air Brakes at Terminals to Avoid Train Shocks and Break-in-Twos.

A lengthy report on the above subject was presented by a committee consisting of B. Heartenstein, chairman; O. R. Bradbury and John Foster. The report emphasized the need of a proper installation and a careful and constant maintenance of the air brake appliances. It was not to be expected that the man or men in charge of the maintenance department should be experts and be able to trace the flow of the air through all the valves or know the size, location and duty of the parts and passages, but that the test rack operator and the man doing the repair work should have sufficient knowledge that he knows how to tell what effect an ordinary defect will produce. He should know that when a triple valve is applied to a car that it has been properly repaired, cleaned and tested, and is suitable for service, for unless it has been, it will defeat the entire purpose of the air brake by preventing it from performing its normal functions which make for safety and economy, and will invariably contribute to heavy financial loss far in excess of the maximum possible cost of maintaining these devices in good operating condition.

The application of levers of improper dimensions and proportions cause brake-rigging failures, slid flat wheels, improper and unequal braking power and a detrimental influence in train handling. Changing brake shoes without readjusting to between seven and eight inches standing travel of the piston is often the direct cause of slid flat wheels, break-in-twos, train shocks and prevents proper manipulation. Applying triple valves to cars without first seeing that branch pipe strainers are inserted and in good condition, and failure to clean out dirt collections at proper intervals, deprives the triple valves of the protection they are entitled to and causes numerous triple valve troubles.

The car foreman must be held directly responsible for knowing absolutely that the man who is actually doing the work is turning out a product of proper character, quality and quantity. In the matter of inspection also care should be taken to examine train pipe for rusted or worn places at body bolster, for defects or corrosion at angle cock nipple, and for condition of retaining pipe at end sill bend, after which brake pipes should be blown out to free them from dirt and pipe scale. Note that pipe clamps are in place and secured, that angle cocks are turned so that they point toward center of track and are located as per M C B standard. When angle cocks are turned to proper angle one side of hexagon portion will be exactly horizontal. When a triple valve is removed its gasket should be removed also and taken to the air brake room for inspection. Cracked, brittle, thin or cut packing leathers must



TESTING DEVICE FOR BRAKE CYLINDERS AND RETAINING VALVES.

be placed in cylinder with thickest part of leather at the bottom of the cylinder. Hard packing leathers may be made pliable by soaking them in brake cylinder lubricant. Piston travel on all cars must be adjusted to between 7 ins. and 8 ins. when brakes are applied with a 20-lb. service reduction from an initial brake pipe pressure of 70 lbs. Piston travel must be adjusted so that line lever on each truck stands at approximately the same angle to top rod when brakes are applied. If necessary to renew any brake shoes they must be renewed before the piston travel is adjusted.

The outgoing freight brake test is, or should be, merely a check against error. Immediately on arrival each train must have a general inspection under blue signals. A thorough brake inspection can now be given, minor repairs made and cars with inoperative brakes marked for repair tracks, all during the time and protection afforded by the general inspection. War time merely emphasizes the need for making the incoming brake test in-

variably and correctly. Road foremen and trainmasters, while on other duties on the engine or in the caboose, should instruct and check against errors and delinquencies. They cannot do so if they get off when entering yards.

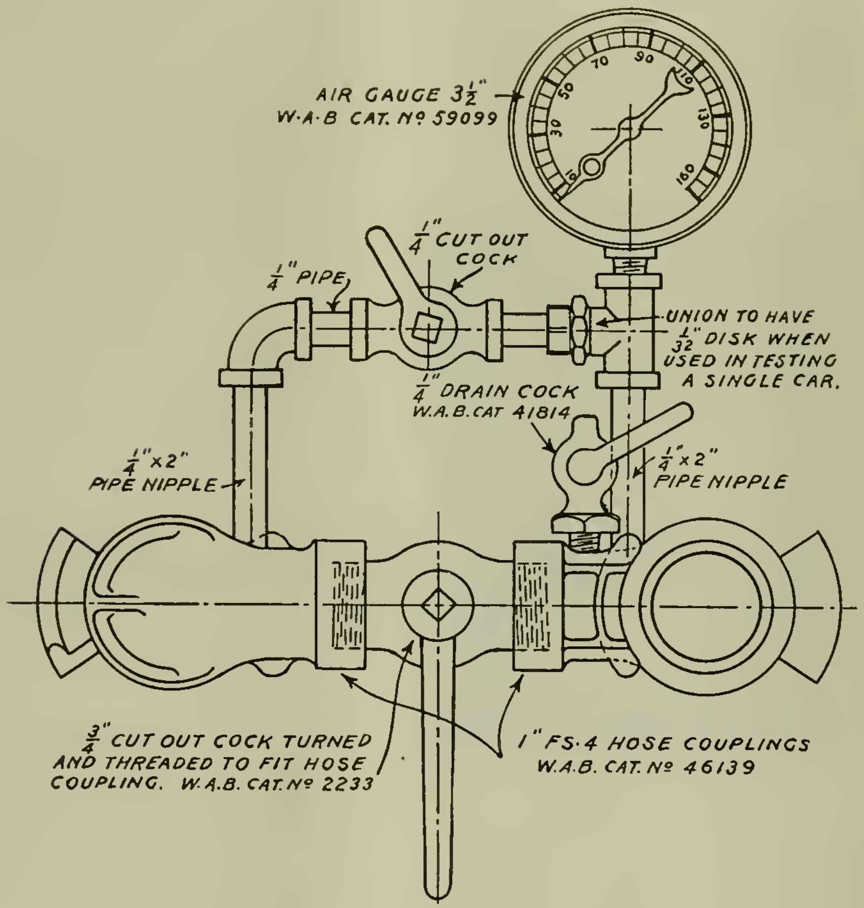
Commenting on brake pipe leakage, the report states that the most common cause for it is poorly clamped piping that will permit shifting of such piping in switch movements or shocks that occur along the track. Allowing train and yard men to pull hose apart instead of separating them by hand, as this produces spread coupling jaws, destroys gaskets and creates porous hose, all of which play an important part in the causes of train shocks, and break-in-twos. Brake cylinder and auxiliary leakage are also productive of damage to trains. Excessive draw bar slack is also a liberal contributor to train shocks and consequent breaks-in-two. With no slack and good draft rigging, trains could not be broken in two.

A variety of other valuable suggestions were advanced by the committee looking toward reducing to a minimum train shocks, the general purport of which were impressing the necessity of seeing that all cars were in good operating condition, piston travel properly adjusted and trains properly handled. In fact, many matters which relate to the efficient action.

8½-Inch Cross Compound Compresser Maintenance.

A comprehensive report on the subject of maintenance of the 8½-in. cross-compound compressor was presented by a committee consisting of C. N. Remery, chairman; T. E. Lyons and Frank Schaller, from which we take the opportunity to make a condensed abstract of some of the salient features.

At the outset the report convincingly pointed out that without the air compressor the railroad train of to-day could not be taken safely down a mountain grade. The position and fastenings of the compressor were fully described. In the handling of the appliance detailed instructions are furnished in the report. Particular stress was laid on the lubrication, and care should be taken that the piston rod swabs should be lubricated with valve oil, the throttle opened gradually, and the compressor run slowly until all condensation is worked out of the steam cylinders, then the drain cocks should be closed. While the compressor is yet working slowly, 10 to 15 drops of oil should be fed to the steam cylinders and 8 to 10 drops to each air cylinder. After obtaining about 40 lbs. pressure the throttle can be opened as required for the service intended. The steam cylinders need about 3 drops per minute in freight service, and nearly as much in passenger service. The air cylinders should be lubricated regularly, 4 to 6 drops, depending on the service, but never over 4 to 6 hours apart in heavy freight service, and especially just before starting down a mountain grade. The use of superheater oil in the compressor was considered by the committee as too heavy, tending to more quickly clog the passageways and packing rings. Better results are said to be obtained from the use of Perfection valve oil, yet where the special 54 air strainer is used no trouble is experienced with the use of superheater oil, thus indicating that gumming with it is mainly due to dirt. The committee favored the use of a separate lubricator for use of Perfection valve oil to lubricate both steam and air ends of the compressor. Considering 4,000 drops per pint of Perfection oil and, lubricating the compressor properly, a gallon of oil should be sufficient to lubricate the compressor eleven sixteen-hour trips.



TESTING DEVICE FOR TRAINS OR SINGLE CARS.

Pounding in the compressor may be caused by the main steam valve being dry, packing rings in low pressure cylinders badly worn, piston rod packing blowing, clogged air passages, air valves with improper lift or leaking, and too much oil in the steam cylinders in combination with close throttling by the steam valve or governor, or the next most common cause may be worn packing rings in the low-pressure air cylinder. By giving the air cylinders a little signal oil through the suction this pound will temporarily be eliminated. The compressor will also pound if it is loose on the bracket or the bracket loose on the boiler. Generally, when a compressor gradually keeps reducing in efficiency until it gets to where it does not maintain standard pressures, the trouble is usually due to the high-pressure air piston rings being worn and leaking. The compressor is sometimes considered at fault for not maintaining standard pressure when the trouble is from frozen pipes or serious brake pipe leakage.

When compressors are sent to the shops for general overhauling, they should first be dismantled and all parts, except the steam pistons and rods and top head, be submerged in boiling lye for about twenty-four hours, after which they should be taken out and thoroughly washed and passages in the air compressor blown out to make sure all lye is removed. The compressor may then be placed on a bench, the parts examined and any hard substances removed by a scraper or chisel. Piston rods, cylinder diameters, and other details should be carefully repaired. When the cylinders are rebored, the standard bevel at edges of ports should be restored. The air valves, air valve seats, cages, caps and stops should all be carefully examined, and all repaired or renewed as may be found necessary.

While no good material should be scrapped, care should be taken to avoid the expensive economy of retaining parts that will not be satisfactory in the next overhauling, as such will cause compressor failures and excessive cost for replacement in the roundhouse.

The Feed Valve—Its Operation and Maintenance.

W. Clegg, general air brake inspector of the Canadian Northern Railway, presented a special paper on the above subject, and in the course of which gave a number of instances in which the feed valve had failed in its operation. Investigation showed that the repairs had been made regardless of whether the repairmen were qualified or not. It was deemed advisable to establish repair points so located as to enable them to handle the feed valve repairs at a minimum cost and delay to outside terminals. The following specifications were developed: Repair points for the handling of feed values to be located preferably at terminals where triple and distributing valves are handled; install rack for testing feed valves as recommended by the Westinghouse Air Brake Company, in a pamphlet, No. 5039, current issue; provide suitable tools, gauges and face-plates, and with instructions for their individual use; discontinuing the practice of supplying feed and reducing valve repair parts to divisional points other than where repairs are being made; arrange with terminal stores department for the expeditious movement of feed and reducing valves complete to and from repair points.

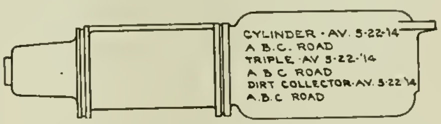
When the valves finally reach the various repair shops they are subjected to the following treatment: They are dismantled and the valve bodies immersed in a lye vat for such duration as may insure the air passages being thoroughly cleaned before removing; supply pistons and valves, regulating parts, etc., are cleaned with gasoline, similar to the methods used in the cleaning of valve parts; the supply valves and their seats are trued up on babbit face plates. Tools such as scrapers, files, etc., are not used for facing up valves or valve seats except in special cases; supply pistons of standard size are used whenever possible. Pistons found worn below standard size are reduced in diameter to gauge, a band which is bored out to gauge is pressed and sweated on the pistons, after which the pistons are turned down to gauge for standard size cylinders, and for gauge 1/64 in. larger than standard.

There may be some question as to reaming cylinders, and applying bands to the supply valve piston; but experience has shown that this practice is commendable in conserving brake material.

It is desirable to place in charge of all repair work the most competent and reliable mechanics, which simplifies largely the question of supervision, and insures each part of the feed valve receiving a careful examination before being allowed to go back into service.

M. C. B. Freight Brake Stenciling for Cleaning, Etc.

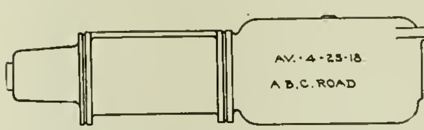
The North West Air Brake Club of St. Paul, Minn., submitted a paper pointing out that the present M. C. B. stenciling for freight brake changing, etc., can be simplified by using but two lines, the upper to show the shop or station letters indicating where the work was done, followed by the numerals indicating the month, day and year; the second to be the initials of the road that did the work.



METHOD OF STENCILING AIR BRAKE CYLINDERS AS PER M. C. B. RULES ONE SIDE ONLY.

Also, duplicate this on the opposite side of the reservoir or car so that one man inspecting can read all dates without frequently crossing over the train, as is now necessary.

The present requirements are to stencil on one side only, and that the shop mark, date and road be repeated each for the "Cylinders," "Triple" and "Dirt Collector," the parts to be lettered as quoted. There is just room enough to get all of it on the auxiliary reservoir of an 8-in. cylinder. The retaining valve is supposed to be cared for at the same time, but there would be no room for a similar stencil for it, even were this desirable, as



PROPOSED METHOD OF STENCILING BOTH SIDES.

it is not. In the case, for example, a triple valve must be changed, usually cared for in the train, and the other parts may be let go, time and money will be saved if the stencil is not changed and, if a foreign car, no charge is made.

It is hoped that the preferred change in the stenciling rule will be favorably recommended to the M. C. B. Association, and will meet with their careful consideration.

Recommended Practice.

A report on the above subject was submitted by a committee consisting of H. A. Clark, chairman; M. E. Hamilton, Charles N. Remery, F. J. Barry, T. W. Dow and N. C. Burns. The majority of the changes were submitted by various air brake clubs, and the committee returned thanks for their co-operation. Among other changes suggested paragraph No. 3, referring to "Air Compressors," should be read: It is recommended that not less than six 1¼ in. studs, properly spaced, be used where compressor is hung low. Paragraph No. 2 should read: Air compressors returned to the shop for repairs should be thoroughly cleaned in boiling lye after dismantling for inspection. Paragraph No. 2 should be further changed to read: Distributing valve of the standard type should be maintained in a condition to apply with a 5-lb. brake pipe reduction, made with the automatic brake valve, and to enable pressure to be graduated out of the brake cylinders in steps of about 8 lbs. at a time. Under heading, "Brake Cylinders," sub-heading "Cleaning and Lubricating," Paragraph No. 1, the words "removed parts and," should be omitted. Paragraph No. 18 should be changed to read: Engine and tender brake cylinders should be cleaned, tested and stenciled in accord with the rules of Interstate Commerce Commission.

Under the heading of "Automatic Slack Adjuster," the following be added: The same lubricant be used in slack adjuster cylinder as in the brake cylinder, also the same attention should be given to slack adjuster with reference to packing leather and expander. Dry graphite should be placed in the ratchet nut to lubricate the screw. Amount of graphite, type "J" adjuster, 10 cubic ins., type "K" adjuster 14 cubic ins. This amount will give the lubrication necessary, and also prevent caking. Under heading "Piping," sub-heading "Piping of Compressors," Paragraph No. 4, change "45 ft. long" to "60 ft. long." This changes the maximum length of equalizing pipe between reservoirs. Add a new paragraph as follows: Equalizing pipe between reservoirs or opposite sides of boiler should be run under and away from boiler with not less than one inch space between jacket and pipe, and should be so located as to provide proper drainage into the second reservoir. Under heading "Piping," sub-heading "Brake Pipe," Paragraph No. 1 should read: Brake pipe in locomotive and passenger equipment cam should be 1¼ in. extra heavy pipe, and on freight equipment cars 1¼ in. standard weight black steel pipe. The pipe to be free from short bends and should not sag or have pockets that might catch water.

Under sub-heading, "Retaining Valve Pipe," Paragraph No. 3, should read: The pipe to be carried along intermediate sill when practicable, from the triple valve to end of car, and be supported by clamps not exceeding 6 ft. apart, first clamp to be six feet from triple valve. The nipple attached to triple valve should

be bent at an angle of 90 degrees, and the connection to main pipe made in a vertical line above triple valve, end of nipple at exhaust port not less than 7 ins. in length. The object of this is to provide flexibility.

The discussions that followed the reading of the various papers were necessarily brief, but some interesting details were furnished, and in nearly every instance the views of the committees were indorsed. On the evening of May 8, Walter V. Turner gave an address on the electro-pneumatic brake, and illustrated the same with moving pictures, showing the admirable adaptability of the device for high class passenger trains. In the open discussions on May 9, the welfare of those members who are in active service in France and elsewhere was warmly dwelt upon, and the earnest co-operation of car and locomotive builders was urged to the end that the recommendations of the association might be universally adopted.

The election of officers resulted as follows: President, F. J. Barry, New York; Ontario & Western. First vice-president, T. M. Lyons, New York Central; second vice-president, L. F. Streeter, Illinois Central; third vice-president, Mark Purcell, Northern Pacific; secretary and treasurer, F. M. Nellis, Westinghouse Air Brake Company, New York.

The members of the Executive Committee continued from last year were: G. H. Wood, Atchison, Topeka & Santa Fe; C. M. Kidd, Norfolk & Western, and R. C. Burns, Pennsylvania. The members of the Executive Committee elected this year embrace M. E. Hamilton, St. Louis & San Francisco, and M. S. Belk, of the Southern Railway.

Questions and Answers

Locomotive Air Brake Inspection

(*Continued from page 156, May, 1918.*)

341. Q.—Has the retain pipe a branch to the straight air brake valve?

A.—No.

342. Q.—Is the automatic brake valve handled the same way during a test as the H-6 valve of the E. T. equipment?

A.—Yes.

343. Q.—Can the brake be released with the straight air valve after the first application of the automatic valve during the test?

A.—Yes.

344. Q.—In what position?

A.—Full release.

345. Q.—Will the handle remain in full release position when the hand is removed from the handle?

A.—No.

346. Q.—Why not?

A.—A spring will return the handle to running position.

347. Q.—What if it does not?

A.—The spring is broken or there is some other disorder that prevents it.

348. Q.—Should such a disorder be reported?

A.—Yes.

349. Q.—Why?

A.—So that the valve handle will not accidentally be in release position when the automatic brake is applied.

350. Q.—What would be the result?

A.—The locomotive brake would not remain applied.

351. Q.—Why not?

A.—The application chamber of the central valve would be open to the atmosphere through the exhaust port of the straight air valve.

352. Q.—What might be the result when handling the brake when the engine is coupled to a train and running over the road?

A.—Under certain conditions of make up of train, it might result in a break-in-two.

353. Q.—What is the difference between a straight air brake valve and the independent valve of the E. T. brake?

A.—The straight air valve admits main reservoir pressure direct to the brake cylinders while the independent valve operated the application portion of the distributing valve.

354. Q.—What governs the amount of pressure admitted to the brake cylinders with the straight air valve?

A.—The reducing valve.

355. Q.—What pressure is it set at?

A.—45 lbs.

356. Q.—Is there any time limit for the application of a straight air brake?

A.—As a general proposition there is not except that the brake should be in a condition to be applied in full almost instantly.

357. Q.—What could be wrong if the straight air brake could not be applied but the automatic brake was working properly?

A.—The reducing valve piston might be stuck shut or the piston of the double check valve might be stuck against the straight air side.

358. Q.—What would you look for if the automatic brake would not remain applied after a brake application?

A.—For a leak in the control pipe, or in the cover gasket of the application cylinder of the control valve.

359. Q.—Is there any other particular difference in the inspection of these two brakes?

A.—No.

360. Q.—Is the signal apparatus and brake pipe feed valve tested in the same manner as with the E. T. brake?

A.—Yes.

361. Q.—What is the difference in the construction of the H-6 and the New York type L brake valve?

A.—There is none.

362. Q.—Then these brake valves are tested in the same manner?

A.—Yes.

363. Q.—What would you think wrong if there was a leak from the control valve exhaust port when the automatic brake was applied?

A.—That the exhaust valve of the application portion of the control valve was defective.

364. Q.—What if the leak occurred when the brake was released or the control valve in release position?

A.—That the application valve was leaking.

365. Q.—What if the leak at the exhaust port occurred only when the straight air brake was applied?

A.—It would indicate that the automatic seat of the double check valve piston was defective.

366. Q.—What would you think wrong if the brake released after an automatic application with a series of sharp exhausts from the control valve?

A.—That the control pipe had burst or was leaking badly.

(*To be continued.*)

Train Handling.

(*Continued from page 157, May, 1918.*)

373. Q.—What is the effect of leaving the brake valve handle on lap position for a time before moving it to service position?

A.—It tends to cause undesired quick action of the brakes.

374. Q.—In what manner?

A.—By permitting brake pipe leakage to start the application provided that the leakage is of sufficient volume.

375. Q.—What is the difference between leakage starting the movement of the triple valve or the brake application?

A.—Leakage moves the triple valve piston to engage the slide valve, usually very slowly, so that there is a tendency for the piston to stop when it engages the slide valve, whereas if the movement is made under the influence of a positive brake pipe reduction, the piston does not stop when it touches or comes in contact with the slide valve and the slide valve is moved promptly to service application position.

376. Q.—What is the effect of the piston stopping when it engages the slide valve?

A.—It closes the feed groove and bottles up the pressure in the auxiliary reservoir while the slide valve is not in a position to allow air from the auxiliary reservoir into the brake cylinder.

377. Q.—What is the general effect if the slide valve has considerable resistance to movement?

A.—The piston hangs on the slide valve until sufficient pressure to again move it is accumulated on the reservoir side of the piston when it finally makes

a quick movement or "jumps" to application position.

378. Q.—What does it sometimes do if it "jumps" to application position?

A.—Compresses the graduating spring and causes the triple valve to operate in quick action.

379. Q.—How?

A.—In the usual manner, as the slide valve travels its full distance in the bushing, a flow of air from the auxiliary reservoir unseats the quick action or emergency valve through the action of the emergency piston and brake pipe pressure is admitted to the brake cylinder.

380. Q.—Does this cause other triple valves in the train to assume emergency application position?

A.—Yes, the serial transmission of the reduction causes the brakes on the entire train to operate in quick action provided that the reservoirs on all of the cars are charged.

381. Q.—What is this movement of the brake valve to lap position before making a brake application slangily termed?

A.—"Loafing on lap."

382. Q.—If the 5, 6, or 7 lbs. brake pipe reduction stops the train at the desired point what should the next movement of the brake valve handle be?

A.—To service application position.

383. Q.—What is the object of moving the valve to service position after the train has stopped?

A.—To make a greater differential in pressure between the auxiliary reservoir and the adjustment of the brake pipe feed valve before a release of brakes is attempted.

384. Q.—Why?

A.—To insure so far as possible a more satisfactory release of brakes.

385. Q.—Why will a brake tend to release more promptly after a 12 or 15-lb. brake pipe reduction than after a 5-lb. brake pipe reduction?

A.—Because there will be a greater difference in the pressure in the main reservoir and that in the auxiliary reservoirs after the application and further there will be less pressure per square inch on the triple valve slide valves.

386. Q.—What is the object of the light initial reduction in passenger service?

A.—Same as in freight service, to secure a low brake cylinder pressure while the slack of the train is adjusting itself, or rather not to suddenly build up enough pressure in any brake cylinder to cause retarding force enough to cause the slack to change quickly.

387. Q.—What do you know about the effect of time in changing draw bar slack?

A.—That slack cannot be changed quickly and gently at the same time and conversely it cannot be changed slowly and harshly at the same time.

388. Q.—What causes rapid changes in slack in trains?

A.—Differences in speed between different vehicles in trains same as in freight train braking.

389. Q.—What generally causes these changes in speed?

A.—Differences in brake cylinder pressure due to differences in brake cylinder piston travel, differences in loading of cars, and differences in the braking ratio employed in different brake installations, it may also be caused by too heavy an application of the brake or through leakage continuing the brake application after the reduction at the brake valve ceases or the changes in speed may be the result of changes in the condition of the track.

(*To be continued.*)

Car Brake Inspection

(*Continued from page 158, May, 1918.*)

354. Q.—What is meant by cylinder value?

A.—The total pressure of compressed air on the brake cylinder piston.

355. Q.—What expression is used if this cylinder value is multiplied more than 9 or possibly 12 times by the levers?

A.—The car is termed as being too high leveraged.

356. Q.—What does this signify?

A.—If the power then developed by the brake cylinder is multiplied too often in obtaining the required brake shoe pressure, there will be some difficulty experienced in securing proper brake cylinder piston travel, and sufficient brake shoe clearance when the brake is released.

357. Q.—What is the effect?

A.—Proper shoe clearance is not provided for the established standards of piston travel of the brake cylinder.

358. Why not?

A.—Because the piston must travel 9 inches or 12 inches as the case may be, to secure one inch of shoe movement.

359. Q.—If the leverage was as high as 14 to 1 as the expression commonly used, how far must the brake piston travel to move the brake shoe ½ of an inch?

A.—7 inches.

360. Q.—What must be done to maintain the leverage ratio as low as 9 to 1?

A.—The proper size of brake cylinder must be used.

361. Q.—What if the car weight is such that an 18 inch cylinder will not develop the required brake shoe force if multiplied but 9 times by the brake levers? How can this be arranged?

A.—Two brake cylinder equipments, or double brake cylinder arrangements must be used.

362. Q.—What is meant by the term braking power?

A.—The power applied to the brake shoes.

363. Q.—What would be a more definite expression?

A.—The term "braking ratio."

364 Q.—Why?

A.—Because "power" is a rate of doing work which is not a factor when an attempt is made to compare "braking power" and the distance in which the car can be stopped by the influence of the brake.

365. Q.—What is meant by the term "percentage of braking power" which will hereafter be referred to as "percentage of braking ratio"?

A.—The ratio of the total brake shoe pressure and the total weight of the car.

366. Q.—How is this percentage found?

A.—By dividing the total brake shoe force by the weight of the car.

367. Q.—What is this braking ratio, or "percentage of braking power" usually termed?

A.—The nominal "percentage of braking power."

368. Q.—What is meant by the word nominal?

A.—Unreal.

369. Q.—Why is this percentage of braking ratio unreal?

A.—Because it is based on the light weight of the car and has no fixed relation to any variation in the load on the car, and the retarding force does not remain constant when the speed of the car changes.

370. Q.—When speaking of air brake performance, is there any relation between the terms "braking power" and "retarding force"?

A.—None whatever.

371. Q.—Why not?

371. A.—Because the calculated brake shoe pressure is not obtained in full because of losses encountered at various points in the foundation brake gear, and the actual retarding force obtained between the shoe and the wheel is very variable, even when the shoe pressure remains constant.

372. Q.—What term is used to indicate the ratio between the average actual stopping force realized and the weight of the car?

A.—The factor of retardation.

373. Q.—Why is the percentage of braking ratio based on the light weight of a car?

A.—To preclude so far as possible the possibility or probability of wheel sliding at low speeds.

(*To be continued.*)

Pacific Type 4-6-2, Built by the Philadelphia & Reading Railway

Not long ago the Philadelphia & Reading Railway, of which Mr. I. A. Seiders is superintendent of Motive Power and Rolling Equipment, constructed in their own shop, and from their own designs, a number of Pacific or 4-6-2 locomotives for their own use. Ten of them are now in service.

These engines were built to handle heavy and fast passenger service, with a limit of weight per pair of drivers of 60,000 lbs., giving a moderately heavy engine of this type. On account of using the engine in fast service, the reciprocating weights have been kept as low as possible, making a light free-running engine.

The front ends are equipped with a new type of spark arrester, which is called the economy front end and it is giving very excellent results in preventing fires along the right-of-way. It does this without adversely affecting the steaming capacity of the engine.

One of the features which is used on the engine which we illustrate is the economy spark arrester. It is a patented device, but was brought out by Mr. I. A. Seiders. He explains that "this device has been developed on the P. & R. as the result of the demand for an efficient spark arrester which will not appreciably reduce the steaming capacity of the locomotive, and has given very gratifying results in service in reducing the expense resulting from right-of-way fires, since the first application over two and one-half years ago. The device has now been applied and in use on more than 475 locomotives."

In building this front end, care has been taken that the hole in square part of table (26 x 26 x ⅛ ins.) round exhaust jet, is for the entrainment of gases without decreasing the size of the exhaust nozzle. The increase of the entrainment surface is obtained without resort to smaller exhaust nozzles or causing back pressure.

The tables placed at the sides of the smoke box are at an angle to prevent the collection of dirt; all fine particles are carried to the bottom on the square part of the table, which is perforated, the exhaust carrying the fine particles out of the stack. The front end arrangement has no bad joints nor openings between the front end nettings, table and smoke arch, forcing sparks to make direct egress to stack.

All the nettings and plates are bolted to a two-inch angle iron which is riveted to the smoke box, secured with additional bands with bolts 6½ ins. apart. The table is not fitted around the blower pipe; but the blower pipe is fitted into the exhaust nozzle below the table line. The table plate is not fitted around the exhaust nozzle, but rests on a flange provided at the top of the nozzle tip, below the table plate, avoiding spark emission. The steam pipe opening at the sides of the plate is secured by plates around steam pipes which are close to the side fittings of the smoke arch, thus avoiding any vibration of the parts, and preventing spark emission. All nettings and plates are arranged in three separate parts and bolted at each joint with additional plates to avoid emission of sparks. With netting and plates in three separate pieces, the center parts may be removed for work at the flues, when necessary, without removing the entire front end, netting or table.

The spark breaker plate, placed directly in front of the flue sheet and back of front end netting, is secured to the flue sheet over the top row of flues under a 1-in. pipe, having 16 pressed openings the full length of each plate; the openings 1-in. wide, pressed out ½ in. away from the plate. The spark breaker plate is of such construction that it will break up the sparks and only the finer particles will pass through the netting in front of it; other and larger sparks will pass to the front of the smoke box and in their course will be reduced and pass out of the netting at front end of the smoke box as fine particles.

This front end has direct draft; it is not necessary to reduce the size of the exhaust nozzle to create a greater draft on the fires, as in other front ends. This device uses solid deflecting plates, resulting in a better steaming engine, and it is spark tight. It is a self-cleaning front end, secured with extra straps at each joint, and only fine particles of dirt are discharged from the stack, which particles are of no consequence. This has been proved by actual test. It is also a fuel saver on account of having dircet draft, being able to increase the size of exhaust nozzle. It reduces the cost of shop maintenance on account of being a self-cleaning front end, avoiding the drawing of fires to clean out the back of the brick arches and chambers on wide fire box engines.

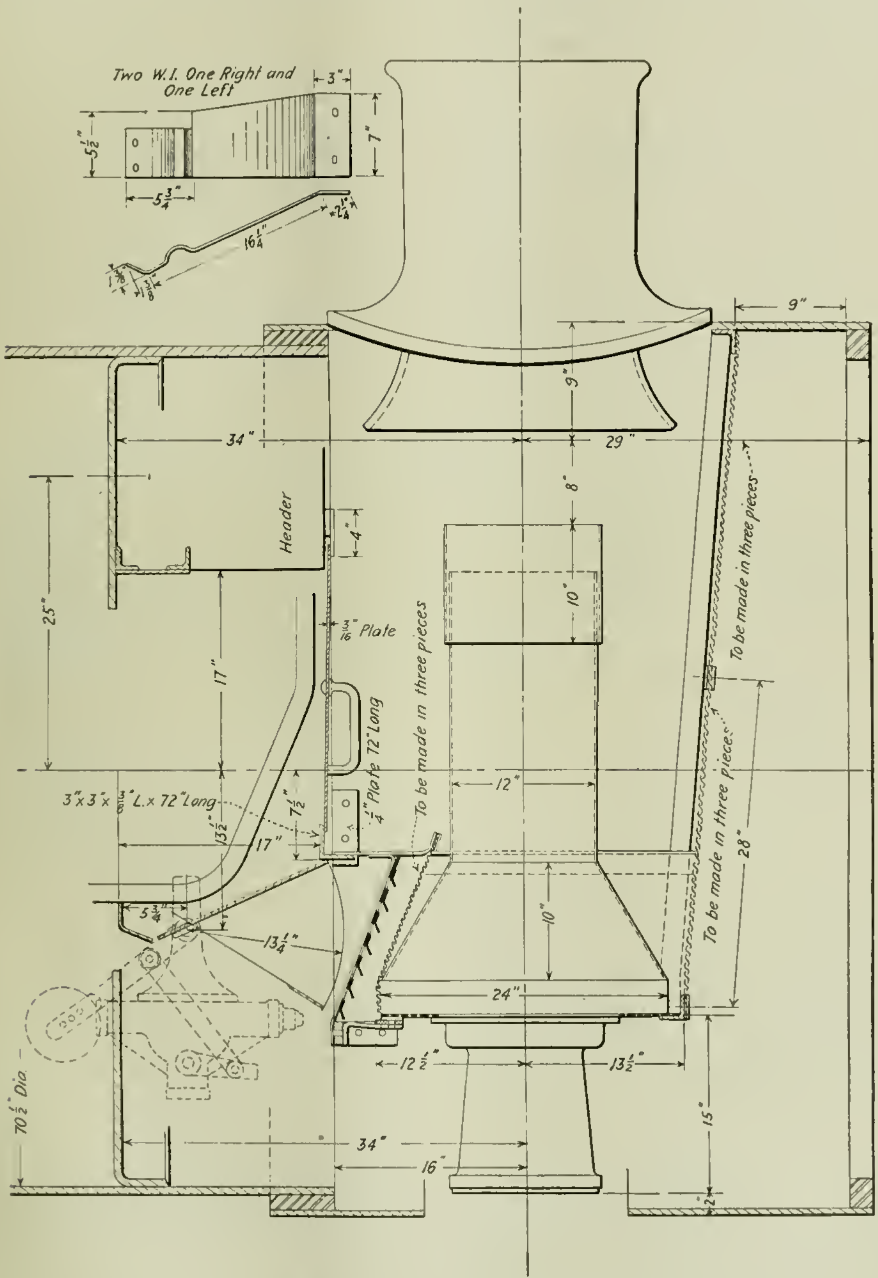
I. A. Seiders, S. M. P. and R. E. HEAVY 4-6-2 ENGINE FOR THE PHILADELPHIA & READING. Builders, P. & R. Railroad.

Some of the dimensions of these engines are as follows:

Tractive effort, 37,187 lbs.; total weight, 273,600 lbs.; on drivers, 176,925 lbs.; on truck, 38,000 lbs.; on trailer, 58,675 lbs.; on tender, loaded, 160,000 lbs.; wheel base, driving, 13 ft. 10 ins.; total, engine, 35 ft. 7 ins.; engine and tender, 67 ft. 11⅜ ins.; diameter of drivers, 80 ins.; total weight of reciprocating parts, 1,237 lbs.; percentage of reciprocating parts balanced 65 per cent, 804 lbs.; dynamic augment at 80 M. P. H. per cent, 41.5 lbs.; cylinders, diameter, 25 ins.; cylinders, stroke, 28 ins.; valve gear, type, Walschaerts; steam pressure, 200 lbs.; boiler, type, Wooten; boiler, smallest diameter, 72 lbs.; boiler, largest diameter, 80 ins.; tubes, 163 and 2¼ ins.; diameter piston valve, 13 ins.; lap, 1⅜ ins.; lead, 5/16 in.; extra clearance, ¼ in.; valve travel, 7 ins.; flues, 30 ft. 5½ ins.; length of tubes and flues, 19 ft.; heating surface, tubes and flues, 2,644 sq. ft.; firebox, 282 sq. ft.; superheater

equivalent, 1,225 sq. ft.; total, 4,151 sq. ft.; gate area, 94.5 sq. ft.; firebox, length, 10 ft. 6 ins.; firebox, width, 9 ft.; kind of fuel, anthracite coal; tender, coal capacity, 12.85 tons; tender, water capacity, 8,000 gals.

RATIOS.—Weight on drivers ÷ tractive effort, 4.76; weight on drivers ÷ total weight, per cent, 64.7; evap. heat. surface ÷ superheater heat. surface, 2.39; firebox heat. surface ÷ total heat. surface, per cent, 6.8; firebox heat. surface ÷ grate area, 2.98; total heat. surface ÷ grate area, 43.9; tractive effort x diameter drivers ÷ heat. surface, 716; total weight ÷ total heat. surface, 66; volume of cylinders, cu. ft., 15.9; total heat. surface ÷ cylinder volume, 261; grate area ÷ cylinder volume, 5.95. The front end which we have described is thoroughly satisfactory to the P. & R.



THE "ECONOMY" SMOKE BOX USED ON THE P. & R. RAILROAD.

Water and Its Usual Ingredients.

Carbonic acid, air and dissolved oxygen, are the agents which accelerate corrosion, and they are present in all waters, in varying quantities. Other impurities common to waters are Carbonates of Lime and Magnesia, Sulphates of Lime, Soda, Potash, and Magnesia, and the Chlorides of Soda (common salt), Potash, and Magnesia, which are the most active corrosive agents. Corrosion in the interior of steam boilers exhibits itself generally in two forms, namely pitting and grooving.

Certain solid substances contained in some waters in service, may either hydrolize or as we would say decompose, and this decomposition results either in an acid (corrosive) condition, or the liberation of an acid in a free or uncombined state, but in either case it results in very rapid and serious corrosion of the metallic surfaces with which the water is in contact. The substances usually found in boiler feed waters which most readily decompose under the above mentioned conditions are Sulphate of Soda (Glauber's Salts), Sulphate of Magnesia (Epsom Salts) and Chloride of Soda (Common Salt). Those that decompose and liberate free acids are Chloride of Magnesia and the Nitrates of Soda and Lime. While the actions of waters containing free acids are by far the most corrosive, such ones are the least common in practice.

On the other hand virtually all waters contain one or more substances which readily assume the acid condition and these are extremely corrosive.

Natural water in practical boiler operation when the feed water actually enters a boiler may be quite different from what it is as it comes from its original source, and such differences often result in the delivery to the boiler of water that is corrosive in its properties, while the contrary was the case with the water in its original condition.

Waters of too high purity, that is, those which are either devoid of solid substances or at most contain but very small quantities of such substances readily induce corrosion. In boilers where a considerable part of the feed water is the water of condensation, there is found to be corrosion. The impregnation of the feed water with fatty acids in the process of condensation, taken up from rancid fats contained in the cylinder oil, is very often responsible for corrosion. Rain water which is usually entirely free from solid mineral substances is known to be the most corrosive in its action, the action in this case being correctly attributable to the presence of minute quantities of gases and soot, which is really carbon, picked up while the water is falling through the atmosphere. A study of the facts concerning any individual source of water supply for locomotives is necessary if permanent improvement is to be had, because ascertaining the cause of trouble must necessarily precede the applying of a remedy.

The walls of a vessel of clean steel is a good conductor of heat. It quickly transfers the heat applied on the "fire side" of the sheet, to the water. So complete is this transfer that the temperature of the sheet is usually only raised a few degrees above that of the water. If the inside of the wall becomes coated even with a thin film of scale or oil or other foreign substance, the heat will not pass rapidly through the film, but will, in great part be retained, or delayed and so raise the temperature to a point where the steel suffers a reduction of its tensile strength. The remedy consists not in "doctoring" the steel, but in removing the cause of these defects and preventing their repetition.

Railway Business Association

The annual meeting of the Railway Business Association, recently held in Chicago, was a great success and many live topics in the railway world came up for discussion. Among these was a report on the change of scope of the association. Mr. Frank W. Noxon, the efficient secretary, read the report, as follows: "The determination of policy now and after the war rests with the government. What that policy shall be will depend upon public opinion. Public opinion will be intelligent in proportion to the thoroughness with which exact knowledge is diffused among the citizens. While the railroad men because they are operating under government direction may not be in position to voice their views freely to the public, the manufacturers of and dealers in equipment, material and supplies are entirely free to make inquiry and publication of the results on any aspect which they view as affecting the national interest or their own.

We have never known business men in this field to manifest so great an anxiety or so thoroughgoing a desire as now for concerted action.

The work falls under two general heads: Development of policy and practice by the Director General of Railroads affecting construction and maintenance of material, equipment, supplies and structures during the war. We recommend a systematic participation by us in public discussion of the problem so far as our occupation gives us special competency to speak."

The question of standardization next came to the front, the secretary, as before, reading the report: Decisions by the Director General or administrative application of policies by his deputies during the war may profoundly affect manufacturers of railway goods. The present Director General has indicated a hospitable disposition toward devices not yet in use. He has also declared that for up-keep and repair, use will be made of the appliances for which existing vehicles were designed.

The purpose to improve car and locomotive design will not only afford the country for the war the most advanced transportation instruments obtainable, but, together with use of existing established devices, will carry through the war into times of peace the occupation of promoting progress in the art of transportation through invention and manufacture.

Such business units have been built up by inventive genius, adequate management and fair dealing; they are established upon the practical demonstration of actual use. To exclude a given maker of appliances for the period of the war with the aim of standardization might signify his permanent disappearance as an industrial factor. It is impossible to foresee in what shapes standardization may be advocated or what criteria may be proposed in sanctioning interchangeable appliances as permitted to bid upon new construction. We do not know what changes in personnel, organization or policy may occur. With constant vigilance we must warn the public and officials against setting up unwise and harmful precedents.

Ultimately, what the country has to fear and what manufacturers should resist is overstandardization, which discourages invention and stifles enterprise and progress.

It is our duty to observe systematically the course of official thought and action and to give those in authority the benefit of our knowledge and opinions and likewise the benefit of public opinion as gathered by us upon the questions involved."

Mr. J. S. Leslie, president of the Leslie Company, in dealing with the status of competing appliances, said he believed that it would help this convention very largely if there was a little more light thrown on the subject in connection with the manufacturing of the products that have to be supplied to the railway companies. The atmosphere seems surcharged with 101 different views of what they appear to understand or do not understand, and if any who have been at Washington have had the opportunity of getting this information, I think the convention ought to have it.

For instance, members have been given to understand that the government will require in the standardization to adopt one device of a certain kind, one make to be used in the railway service. Others have an understanding that their idea is to have two or three of the leading devices selected, and that they be made interchangeable so as to fit. Others have the understanding that in order to be able to quote on any of their requirements the bidder is required to submit in detail the cost of the raw materials.

Mr. McAdoo was quoted as saying when asked about the government attitude that he wanted it distinctly understood that he thought the condition ought to be very encouraging to improvement, because instead of having to have tests and trials made in a great variety of cases, that the tests made by one, the experience of one road, will be available for all. He said: We should expect from the railroad company which has entered into an investigation and got such results an explanation as to what their conditions are, why they believe that those results were of value to them, either for or against, and to explain at the same time what their conditions were, so that it might not show for similar work on other railroads where the results might be different owing to different conditions. He wished it clearly understood that his attitude was that of encouraging everything of that kind, and of permitting it, but that there were two requirements: first, that application be made for permission if it involved any expenditure; and the second, that the result should be reported promptly and fully to the Administration at Washington.

The difficulties of standardization were touched on and the speaker said:

The general dimensions of a locomotive and the location are perfectly easy, in my mind, but there are so many specialties that are applied to locomotives in these days of advancement that are made for the same use but that are of widely different dimensions. If the dimensions of those particular specialties must be made interchangeable, one with the other, isn't it going to work a great deal of hardship on the different manufacturers to compromise their dimensions to meet the dimensions of other designs? I found out in standardization we had really to get compromise from all sources. In fact, in one particular case we had to make brakes, of which there were two independent companies at that time, the New York Air Brake, and the Westinghouse Air Brake, and we had to get them to follow each other's designs to the elimination of their own standards. What I want to inquire is, is it the intention by this present standardization that two specialties, each performing the same function, must meet the exact dimensions to go on that locoomtive or that car or they will not be considered in any manner whatsoever?

The intention is to eventually make all injectors so that no matter where the road is situated, any injector that is taken off can at once be replaced by any other, even of an entirely different make. This does not alter the features of the design which the maker may have brought out and which he believes adds to the value of his product, but it results in a dimentional standardization which in car-building is not new to the railway world. This same idea is to be made to apply to safety valves, piston and valve stem packing, lubricators and other of the necessary devices.

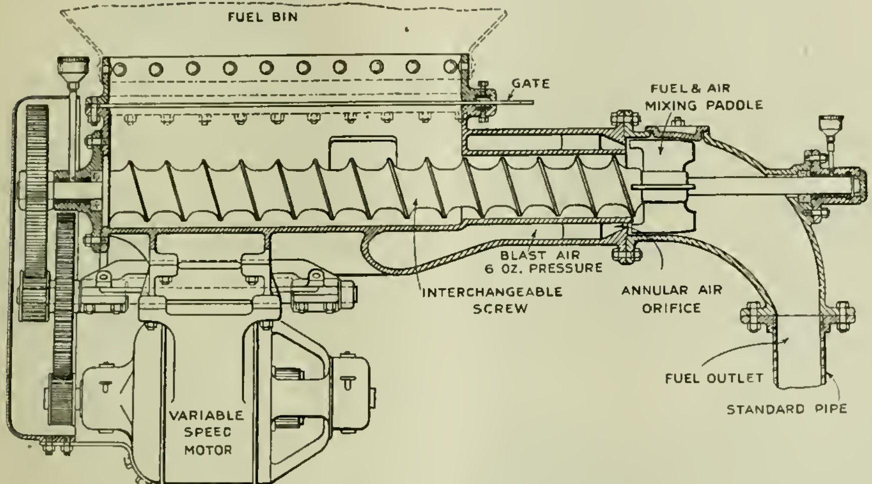
Mr. Post then said: "I feel it proper to call attention to the fact that the Director General of Railroads explicitly disavows that he is a railroad man; he has turned to railroad mechanical men and asked them to speak out about standardizing locomotives.

"Lopulco" Feeder for Pulverized Fuel

A new device for feeding pulverized coal or lignite has been perfected and tested by the Locomotive Pulverized Fuel Company, of New York. It contains several features now calculated to meet the requirements of the service in a manner hitherto unapproached in efficiency and adapted to any pulverized fuel installation, insuring the burning of the fuel in suspension the same as oil or gas. The improved feeder is the result of four years of careful study, and the result of the tests on locomotives, steam-power plants and other service have more than justified the expectation of the designers.

As shown in the annexed drawing, the feeder is motor driven. The power required ranging from 1/4 to 2 horse-power. The standard motor equipment is 230-volt D. C. variable speed control, but special motors may be provided to meet complete control at all times, precluding the possibility of flooding or stoppage of feeding. As will be observed there is a long contact of fuel screw with the fuel in the bins, the single bin supplying any number of feeders without structural complications. A single feeder may also be so equipped as to supply multiple burners, the substitution of feed screws of different pitch being the only change necessary to increase or decrease the capacity beyond the limits of the normal speed range.

The marked economical advantages in the use of pulverized fuel has been repeatedly pointed out in our pages, but it may be again re-stated that the general results are: the ability to utilize the cheapest grade of locally available fuel, the absolute use of from 95 to 98 per cent of the heat value, irrespective of the



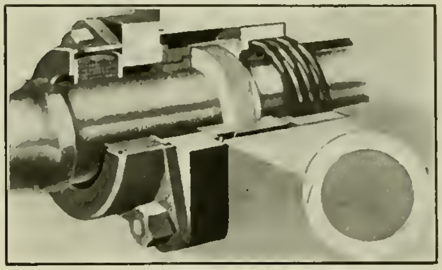
"LOPULCO" COMBINATION FEEDER AND MIXER.

the requirements of the service, the quantity of fuel fed being proportional to the speed of the feed screw, and the pitch and depth of the screw. For example, a 5 ins. feeder equipped with a 3½ ins. pitch screw has a minimum capacity of 850 lbs., and a maximum capacity of 3,400 lbs. of fuel per hour, with twelve intermediate steps. Feeders using as low as 60 lbs. of fuel per hour and as high as 4,000 lbs. are already in operation and working effectively and economically.

The feeder is of heavy, durable construction throughout. The gears are of machine-cut steel, pinions of rawhide and the interchangeable screw is of cast iron. The bearings are extra long, and the joints are all ground or milled, and where necessary felt gaskets are used. All the parts are readily accessible, and the operation is noiseless and entirely free from leakage. The air for feeding and mixing is supplied by a blower of 6 oz. pressure, and the appliance is under ash content, the elimination of grates, retorts and other metal equipment, and a continued maintenance of the highest rate of combustion per cubic foot of furnace volume, without loss in internal efficiency.

King Metallic Piston Rod and Valve Stem Packing.

Continued improvements are being made on piston rod and valve stem packing, among the most popular being a reduction in the number of parts in what is known as the King metallic locomotive piston rod packing, and locomotive valve stem packing. Our illustrations show the extreme simplicity of the design. The packing ring, it will be observed, is in two parts only, which interlock when assembled on the rod. This is an important advance in the right direction, and is of great value when compared with many varieties of packing where the rings are in four or five pieces, and are frequently complicated by either garter or flat springs. The chief advantage is that there is but one ground joint—that between the gland and the sliding plate. It will be noted that the bevel of the King packing is toward the cylinder. A special metal



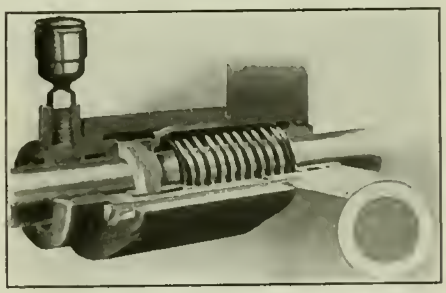
KING PISTON ROD PACKING.

also, having a high melting point, is used in the packing rings when applied to locomotives equipped with superheating appliances.

In the case of the valve stem packing, there is also only one ground joint, as in the piston rod packing—that between the sliding plate and gland. The support shown at the back of the spring and resting on the cylinder head is only used in the case of locomotives equipped with slide valves, and is not used in packings for engines having piston valves.

These improved and simplified forms of piston rod and valve stem packings have been tried in every kind of steam locomotive service, and have met with the warm approval of all who have had an opportunity of observing their adaptability to the varying requirements of the service. The United States Metallic Packing Company, Philadelphia, Pa., are the manufacturers of the improved designs of packing.

It should be borne in mind that in the universal cry for economy in present-day railroad practice much attention has been given to suppressing the loss incident to the blowing off of safety valves, but at the most the loss in this way is only at



KING VALVE STEM PACKING.

intermittent distant intervals, whereas a leak in the piston rod or valve stem packing is continuous, and packing that is free from complicated parts and easy of repair or renewal is of greater value than may be at first considered; in any case it makes for economy, and that is what all of us desire.

Electrical Department

Lightning Arrester and Ground Connection—Conductivity and Catenary Construction

Last month we described the construction of the electrolytic lightning arrester. There are a few additional points which were not then mentioned and which are very important. A useful point to constantly remember when assembling and erecting an arrester of this type, is that all parts of it must be absolutely clean. A very small quantity of dirt in the tanks or trays may prevent proper operation of the arrester and spoil the electrolyte. In preparing the trays for assembling, they should be examined to see if they fit properly together and should not be filled with electrolyte until ready for assembling in the tanks and just immediately before the arrester is to be put into service.

Absolute cleanliness must be obtained while handling the electrolyte. It and the trays must be kept free from dust. If it becomes slightly impure an excessive current will flow when the arrester is being charged and if there is a large amount of impurity present, the charging current will be excessive and the arrester will not operate satisfactorily. The

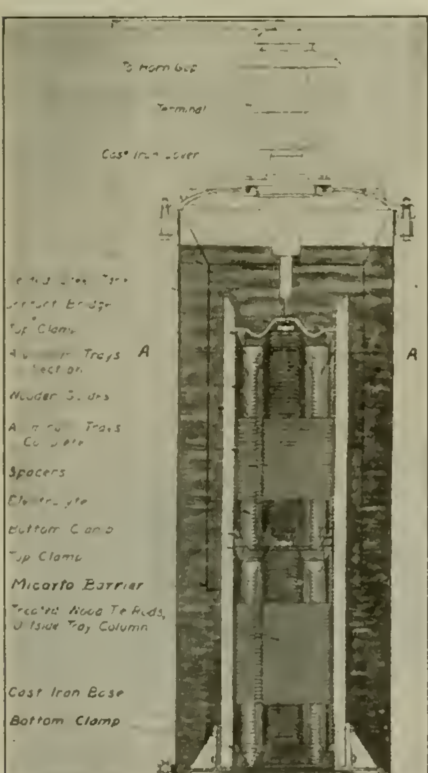


FIG. 1. SECTION OF TYPICAL ELECTROLYTIC ARRESTER.

oil, inasmuch as it frequently contains fragments of iron scale, should be filtered before being placed in the tank. When the trays are in position, the oil should be carefully poured, syphoned or pumped slowly into the tank so as to avoid splashing it into the trays. The electrolyte which is but slightly heavier than the oil, will be washed from the trays unless care is taken. Sufficient oil should be placed in the tanks so that all of the plates are submerged in the oil.

Another point to consider in connection with the installation is the ground connection. As previously mentioned the lightning arrester is connected, one end to the power wire and the other end to the ground, thus acting as a safety valve to take off the high voltages or lightning charges and allowing same to dissipate into the ground. Too much importance cannot be attached to the making of proper ground connections. These should be as short and straight as possible. A poor contact will render ineffective every effort made to divert the static electricity into the earth. Many lightning arrester troubles are traceable to poor or defective ground connections. Ground connections may be two classes. First, existing grounds, and second, constructed grounds. Existing grounds are, for instance, underground pipe systems such as a city water main. This furnishes an excellent ground because of the great surface of pipe in contact with the moist earth and the large number of alternative paths for the discharge.

There are, in general, two different types of constructed ground namely: The buried plate ground and the iron pipe ground. The buried plate ground is made as follows and is illustrated by Fig. 2. First, dig a hole four ft. square as near the arrester as possible until permanently damp earth has been reached. Next cover the bottom of this hole to the depth of 2 ft. with fresh coke or charcoal (about pea size). Then over this lay 10 sq. ft. of tinned copper plate. After doing this, solder or rivet the ground wires securely across the entire length of the ground plate, and cover the ground plate with 2 ft. of fresh coke or charcoal. Then fill the hole with earth and have plenty of common salt sprinkled in it, using running water to make it settle. This method of making the ground connection has given excellent results. However, if not constructed in proper soil, it may prove of little value.

The iron pipe ground is simple and effective and is formed by driving galvanized iron pipes into the earth. A multiple pipe ground is generally used, for pipes spaced approximately, 8 to 10 ft. apart. An arrangement of seven pipes in parallel is very good for this purpose. They may be arranged in the form of a circle, six pipes around a central one. Plenty of salt should be sprinkled on the surface of the earth about the place where the pipes are driven. The salt is

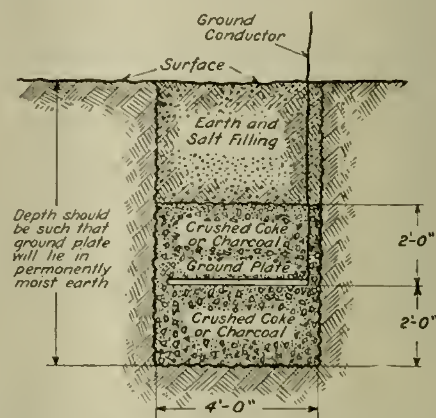


FIG. 2. METHOD OF MAKING A GROUND.

an aid to holding the moisture and creating a good ground.

Proper soil must be available in order to secure a satisfactory ground. Clay, rock, sand, gravel, dry earth and pure water are not suitable material in which to place a lightning arrester ground. Rich soil is the best; one that is damp and containing some solution of acid, alkali or salt. In addition to the above-mentioned grounds, a good many times advantage is taken of a stream of water for a ground. This may or may not be effective. If the bed of the stream is rocky, the ground plate is more or less insulated, especially at a mountain stream where the water is pure. Earth connections or grounds should be periodically examined and tested for resistance at least once a year to ascertain their condition.

Conductivity.

In the article, in this issue, on the electrification of the Chestnut Hill Branch of the P. R. R., out of Philadelphia, mention is made of the conductivity of the overhead and signal wires, and it is expressed in terms of copper wire. A few words in explanation may be of benefit

As we all know, metals are conductors of electricity, but while they conduct the electric current, there is wide variation in the amount of electricity which each will carry. No two metals have the same properties and while one metal may be specially adapted for use as a conductor of electricity, another may not on account of its resistance.

A term is applied to this property of a

metal in virtue of which it conducts electric current, it is called conductance. Conductance is used as the inverse of resistance. The conductance of a piece of any material 1 cm. long and 1 sq. cm. in cross section is called its specific conductance or conductivity. Percentage conductivity of a substance is the ratio of its conductivity to that of the standard at the same temperature. The standard is taken as pure copper at 0 degs. C., i. e., the conductivity is 100 per cent.

A table of relative conductances of the different metals follows:

Metals at 0 degs., C.	Relative Conduct'ce
Copper (annealed)	100 per cent
Copper (hard)	98.1 " "
Silver (annealed)	105 " "
Silver (hard)	98 " "
Gold	76 " "
Aluminum	54 " "
Platinum	17 " "
Iron (pure)	16 " "
Iron (telegraph wire)	10 " "
Lead	8.3 " "
Mercury	1.6 " "

It is an interesting fact that conductivity of electric current in metals is closely related to the ability of the metals to conduct heat. It is found that those substances that possess a high conducting power for heat are also the best conductors of electricity. Take for instance iron and silver. We all know that the blacksmith heats up and works one end of an iron rod holding the other end in his bare hand without discomfort, while a silver spoon is held by the end of the handle with difficulty, if the spoon is placed in a bowl of boiling water. The iron conducts the heat back very slowly, the silver carries it very rapidly. We would expect then that the silver had a high conductivity for electricity and the iron a low conductivity. Referring to the table it will be seen that same is true—the silver is higher than the copper while the iron is 1/10 that of copper.

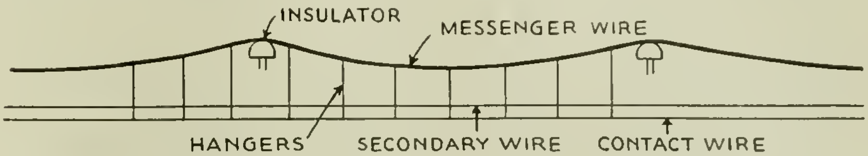
Though aluminum has a conductivity of approximately ½ that of copper, still it is a better conductor than silver (weight for weight). The comparative weights of equal volumes of aluminum and copper are as 1 for aluminum and 3.33 for copper. Therefore the relative weights of given lengths of same conductivity will be as 47.77 for aluminum to 100 for copper. That is the weight per mile of aluminum wire is 47.77 per cent of the weight of the same length of copper of the same conductivity.

Catenary Construction.

Reference is made in one article on the "Cestnut Hill Electrification" to the "messenger" wire. What is the "messenger"? It is part of the overhead trolley construction. The overhead trolley construction is of the so-called catenary construction and is composed of three wires bound together by spacing rods or hangers, as they are called; the whole supported on insulators or bracket arms, or on cross supports.

The arrangement of the wires is shown in the engraving. A steel cable is strung over the supporting insulators, to which are bolted the hangers carrying the secondary and contact wires. The steel cable is allowed to sag, and the curve which this cable takes when equally loaded is a curve known as the catenary—hence the name for this type of construction. This curve is what is known as a roulette of the parabola, and is therefore a sort of distant relation to the conic sections. We made reference to this in our article on headlights, published in our January, 1918, issue, page 10. This is the curve that the supporting cables of a suspension bridge assume, when equally loaded over their entire length. If you want to see the outline of a catenary curve look at a picture of the Brooklyn Bridge, or look at the bridge itself.

The word comes from the Latin "catena," a chain, and gets its name from the fact that a chain, equally loaded or unloaded, and supported at its ends, will hang freely in this position. The hangers carrying the other two wires are equally spaced so that the steel messenger wire is equally loaded throughout. The hangers are of different lengths, so that the contact wire is horizontal. The catenary, the messenger and the contact wires are all charged.



SKELETON OUTLINE OF CATENARY CONSTRUCTION.

This type of construction has many points of superiority over the old method of trolley construction. The messenger cable is of stranded steel wire, and can be of any desired size necessary to support the other wires, and to provide a factor of safety. This construction can be likened to the cable bridge. The cables take the catenary curve, and can carry the whole weight of the bridge, which is nearly horizontal, the cables being equally loaded throughout. The name catenary, however, originated as describing a cable which was not loaded. The application of an equal load throughout its entire length was found not to alter the form of the curve in any way.

OVERHEAD CATENARY CONSTRUCTION ON CURVE.

Nickel Plating.

Light nickel plating can be readily accomplished by heating a bath of pure granulated tin, argol and water by boiling, and adding a small quantity of red-hot nickel oxide. A brass or copper article immersed in this solution is instantly covered with pure nickel.

Items of Personal Interest

Mr. G. A. Hillman has been appointed shop demonstrator at the Meadville shops of the Erie.

Mr. S. C. Carlough has been appointed supervisor of locomotive operation of the Erie, with office at Secaucus, N. J.

Mr. Frank Beatty has been appointed supervisor of locomotive operation at the Erie, with office at Port Jervis, N. Y.

Mr. M. O. Griffith has been appointed general foreman of the Santa Fe shops at Clives, N. M., succeeding Mr. J. A. Klasner.

Mr. Henry Reiff has been appointed machine shop foreman of the Erie, with office at Marion, Ohio, succeeding Mr. J. Strawser.

Mr. S. Heckathorne has been appointed master mechanic of the Anthony & Northern, with office at Pratt, Kan., succeeding Mr. S. C. Raff.

Mr. T. Stewart, formerly master mechanic of the Baltimore & Ohio, at Connellsville, Pa., has been transferred as master mechanic to Cumberland, Pa.

Mr. T. Hambley has been appointed master mechanic of the Canadian Pacific, with office at North Bay, succeeding Mr. C. Gribben transferred to St. John, N. B.

Mr. T. J. Bell has been appointed superintendent foreman of the car department of the Erie, with offices at Cleveland, Ohio, succeeding Mr. M. Eagan, resigned.

Mr. G. H. Berry has been appointed assistant master mechanic of the South Louisville shops of the Louisville & Nashville, succeeding Mr. B. E. Dupont, transferred.

Mr. W. M. Harding has been appointed general foreman of the Cincinnati, New Orleans & Texas Pacific, with office at Oakdale, Tenn., succeeding Mr. D. H. Andrews.

Mr. Frank A. De Wolff, formerly master mechanic at the Sagua-la-Grande shops, Cuba, has been appointed superintendent of locomotives, with the same headquarters.

Mr. T. V. Beardmore has been appointed locomotive foreman on the Canadian Pacific, with office at Schreiber in the Algoma district, succeeding Mr. R. Gardner, resigned.

Mr. W. E. Frazier has been appointed road foreman of engines on the Baltimore & Ohio, succeeding Mr. J. E. Fisher, appointed train master, both with offices at Garrett, Ind.

Mr. H. J. Bell, safety inspector of the Chicago & North Western, has been appointed safety supervisor of the railroads under the jurisdiction of the western regional director.

Mr. G. Brown, formerly master mechanic of the Wrightsville & Tennile, with office at Tennile, Ga., has resigned to enter the service of the Georgia, Florida & Alabama, with office at Bainbridge, Ga.

Mr. Garland P. Robinson, formerly assistant chief inspector of locomotives for the Interstate Commerce Commission, has been appointed assistant manager of the locomotive section of the Railroad Administration.

Mr. George G. Yeamans has been appointed general purchasing agent of the New York, New Haven & Hartford, and Mr. G. W. Hayden assistant purchasing agent. The purchasing and stores departments have been consolidated, with headquarters at New Haven, Conn.

Mr. F. N. Fritchey, formerly of the division of locomotive inspection of the Interstate Commerce Commission, District 15, has been appointed superintendent of shops of the Wheeling & Lake Erie, with office at Brewster, Ohio.

Mr. John L. Smith, formerly master mechanic of the Pittsburgh, Shawmut & Northern, with office at St. Mary's, Pa., has been appointed superintendent of motive power and equipment.

Mr. W. Wright, formerly division master mechanic of the Canadian Pacific, at Toronto, Ont., has been transferred as division master mechanic to Brownsville Junction, Me., succeeding Mr. C. Powers, who has been transferred to Toronto.

Mr. G. F. Johnson, formerly general master mechanic of the Chicago, Burlington & Quincy, with office at Lincoln, Neb., has been appointed assistant superintendent of motive power at Lincoln, and his former position has been abolished.

Mr. O. R. Hale, formerly assistant superintendent of locomotives of the Cuban Central railways, with office at Sagua-la-Grande, Cuba, has been appointed superintendent of locomotives, with the same headquarters, succeeding Mr. F. A. De Wolff.

Mr. J. A. Conley, formerly master mechanic of the Atchison, Topeka & Santa Fe, at Raton, N. M., has been transferred to the Valley Division, with office at Fresno, N. M., succeeding Mr. John Pullar, transferred to San Bernardino, Cal.

Mr. J. R. Slater has been appointed roundhouse foreman of the Chicago, Milwaukee & St. Paul, at Savanna, Ill. Mr. Howard Gentine has been appointed night roundhouse foreman at Perry, Ia., and Mr. H. Collins has been appointed roundhouse foreman at Kansas City, Mo.

Mr. H. K. Fox, formerly chief draughtsman in the motive power department of the Western Maryland, at Hagerstown, Md., has been appointed engineer of tests of the Chicago, Milwaukee & St. Paul, with headquarters at Milwaukee, Wis., succeeding Mr. W. Bennison, resigned.

Mr. Stephen G. Mason, of the McConway & Torley Company of Pittsburgh, has been elected president of the National Association of Manufacturers. The office of the association is at 30 Church St., New York, vice Col. George Pope, deceased. The other officers elected were Mr. J. Philip Reid, general manager; Mr. Henry Abbott, treasurer, and Mr. George B. Baudinot, secretary.

Mr. A. B. Enbody, formerly assistant master mechanic of the Central of New Jersey, with offices at Mauch Chunk, Pa., has been appointed master mechanic of the Lehigh & Susquehanna division, in charge of locomotive and car departments, and assignment of power, with office at Ashley, and Mr. C. W. Culver, formerly foreman at Mauch Chunk, has been appointed assistant master mechanic of the Lehigh & Susquehanna division, with office at Mauch Chunk.

Mr. H. S. Patterson has been appointed manager of the railroad department of the Walworth Manufacturing Company, with headquarters in Boston. Mr. H. T. Goodwin has been appointed assistant manager of the railroad department, with headquarters in New York. Both Mr. Patterson and Mr. Goodwin obtained their training with the National Tube Company by taking the Specialty Course at Kewanee Works of the National Tube Company (now the Walworth Manufacturing Company). Mr. Goodwin will probably be remembered by many railroad mechanical officials as the son of Mr. J. T. Goodwin, past president of the Master Boiler Makers' Association.

Mr. H. Clewer, superintendent of fuel economy of the Chicago, Rock Island & Pacific announces the following appointments as supervisors of fuel ecenomy: Mr. J. Benzies, Chicago terminals and Illinois division, with headquarters at Rock Island, Ill.; Mr. B. J. Bonner, East Iowa and Minnesota divisions, at Cedar Rapids, Iowa; Mr. P. Smith, Dakota and Des Moines valley division, at Valley Junction, Iowa; Mr. F. Meredith, West Iowa; Nebraska and Colorado divisions, at Fairbury, Neb.; Mr. C. W. Reed, Missouri, Kansas City Terminal and St. Louis divisions, at Trenton, Mo., and Mr. F. Connolly, Kansas and El Paso divisions, at Herington, Kan.

Mr. J. A. McFarran has been appointed master mechanic of the M & M division and branches of the Louisville & Nash-

ville, with office at the Montgomery shops, the position of assistant-master mechanic at Montgomery having been abolished. Mr. T. F. Ryan has been appointed assistant-master mechanic of the Cincinnati terminals and Kentucky division with office at the Central Covington shop. Mr. F. W. Oakley has been appointed master mechanic of the Eastern Kentucky division, with office at Ravenna, Ky., shops, and Mr. B. E. Dupont has been appointed master mechanic at Howell, Ind., shops, Henderson and St. Louis divisions and St. Louis terminals.

Mr. Edward Buker has been appointed Western representative of the Rome Iron Mills, Inc., with office in the McCormick Building, Chicago, Ill. Mr. Buker is a graduate of the University of Illinois, from which he received the degree of Mechanical Engineer. He entered as an apprentice in the shops of the Pullman Company, and latterly in the shops of the Illinois Central. Later he was appointed inspector on the Chicago, Rock Island & Pacific, and after filling the position of general foreman on the same road, he was appointed master mechanic on the Missouri, Kansas & Texas. During the last two years he has been engaged as a mechanical expert with the Galena Signal Oil Company, which position he held at the time of his recent appointment.

Mr. C. Z. Moore, as a representative for John Lundie, D. Sc., will locate in Philadelphia, Pa., with office in the Finance Building. Mr. Moore has identified himself with Dr. Lundie, of 52 Broadway, New York, who is the inventor and patentee of the Lundie tie-plate used extensively in track work on railways. Mr. Moore is a railroad man of broad experience, especially in track work, having devoted 19 years of his life to service in the Maintenance-of-Way Department of the Pennsylvania Railroad Company. In the last five years he succeeded in capturing the prize each year, offered in competition by the General Manager to the man in charge of any section showing the greatest improvement and maintaining tracks in the best condition of any on the system.

Mr. Joseph Robinson, of the Robinson Connector Company, of Branford, Conn., has been working very steadily during the past winter. The severity of the weather in the winter months has, almost automatically, assisted him in the demonstration of the efficacy of his device. The connector, which unites steam, air and signal hose, was not only easily uncoupled in the coldest days, but when in use it kept tight, and freezing was entirely absent. Mr. Robinson has met with much gratifying success in Canada. He has left the business care of his device in able hands and has started on an automobile trip, with his family, across the continent. He will pass close to Chicago, visit Denver and finally traverse the mountain roads and winding pathways of the Rockies. The wonders of the Yosemite valley and the Yellowstone Park will unfold their glories to the party toward the end of the trip. Mr. Robinson intends to return to the "Connector" in the early fall. We all wish his well-deserved rest will do him good.

Mr. V. R. Hawthorne has been elected acting secretary of the Master Car Builders' Association and the Master Mechanics' Association, at a meeting of the Executive Committees of both associations held in Chicago on May 13 to fill the vacancy caused by the death of the late secretary, Mr. Joseph W. Taylor. Mr. Hawthorne is from Oleana, Pa., and has had a wide railroad experience, especially on the Pennsylvania, where he was

V. R. HAWTHORNE,
Acting Secretary M. C. B. and M. M. A. Assn.

engaged in the car department, and was special M. C. B. inspector. He has served on the Master Car Builders' price committee preparing time studies. Mr. Hawthorne has also assisted Mr. Taylor in the preparation of his annual and other reports, and is in every way, both by education and experience, eminently qualified for the position of the secretary of the joint associations.

Mr. Alba B. Johnson, president of the Baldwin Locomotive Works, Philadelphia, has recently been elected to the presidency of the Railway Business Association, replacing Mr. Geo. A. Post, retired. Mr. Johnson's long connection with one of the most prominent industrial concerns in the country and his ability and success with that important industry, more than fits him to carry on the work of the Association, which has been carried on with exemplary power and efficiency to the satisfaction of all of its large list of members.

Joint Meeting of M. M. and M. C. B. Associations.

The American Railway Master Mechanics' Association and the Master Car Builders' Association have issued a joint circular calling a meeting to dispose of all work of committees and to pass on other matters. All representative members, the chairmen of all committees, the executive committees of both associations, and the arbitration committee of the Master Car Builders' Association are invited to attend the meeting, which will be held in the Florentine Room of the Congress Hotel, Chicago, on June 19 and 20, 1918.

The M. C. B. Association will receive reports from the committees on arbitration; standards and recommended practice; brake shoe and brake beam equipment; couplers; loading rules; car wheels; specifications and tests for materials; train lighting and equipment; tank cars, and welding truck side frames, bolsters and archbars. The Master Mechanics' Association will present reports on standards and recommended practice; mechanical stokers; fuel economy and smoke prevention; specifications and tests for materials; train resistance and tonnage rating; springs.

The reports of the committees will not be sent out to the members in advance of the meeting, copies will be distributed to those attending. Headquarters will be at the Congress Hotel. There will be no exhibit of appliances in connection with the meeting.

The American Society of Mechanical Engineers.

The annual meeting papers for the December, 1918, meeting should be in the hands of the secretary by September 20. Papers are solicited for this meeting, and for any of the meetings held by the 22 local sections in different cities throughout the country. Brief contributions of less formal character are also desired, containing notes of experience, results of investigations, accounts of new work, engineering data, discussion of society affairs, etc. Such communications can often be used otherwise, even if unavailable for a meeting. The society has 9,000 members, everyone of whom may be helped by a contribution from a single member.

Packing and Lubricating.

The Q. & C. Company announce that they have taken over the manufacture and sale of packing and lubricating for some time under the Thomas Smith patents, formerly operated and controlled by The B. H. Jones & Co., of Boston, Mass. The devices will be hereafter known as the Q. & C. Packing and Q. & C. Lubricating.

Railroad Equipment Notes

The Baltimore & Ohio is in the market for 100 steel under-frames for caboose cars.

The Michigan Central Railroad, it is said, will build a car repair shop at Bay City, Mich.

The Alabama & Vicksburg has ordered 3 Mallet type locomotives from the Baldwin Locomotive Works.

The Colorado & Wyoming has ordered ten 50-ton gondola cars from the Western Steel Car & Foundry Company.

The Canadian Government has placed orders for 8,150 freight cars, some of which are to be built in this country.

The Chimo Copper Company, Salt Lake, Utah, has ordered 24 underframes from the Pressed Steel Car Company.

The Ferrocarriles Delnorte de Cuba have ordered five ten-wheel locomotives from the Baldwin Locomotive Works.

The Canadian Northern will build a coaling plant, roundhouse, ice house, etc., at Leaside Junction, Ont., to cost about $80,000.

The American Steel Co., Bridgeport, Conn., is reported ordering fifty 60-ton steel hopper cars from the Pressed Steel Car Company.

The Pennsylvania will build repair shops, roundhouse and make other terminal improvements to the extent of about $1,000,000 at Wheatland, Pa.

The Baltimore & Ohio has ordered a 48-lever interlocking switching machine from the Union Switch & Signal Company, for installation at Outville, Ohio.

The Louisville & Nashville will rebuild its wheel and axle shop at South Louisville, Ky., recently destroyed by fire, with an estimated loss of $75,000.

The Pennsylvania Railroad, Lines West, has ordered a 32-lever machine from the Union Switch & Signal Company for installation at Smithfield, Ohio.

The Wittaker Glessner Company, Portsmouth, Ohio, has ordered four 50-ton gondola and seven 50-ton hopper cars from the Pressed Steel Car Company.

The Hocking Valley has awarded a contract to the Roberts & Schaefer Company for the installation of Robertson coaling conveyors at Toledo, Ohio, and Marion.

The American International Steel Corporation, New York, is inquiring for twenty-five 18-ton and twenty-five 22-ton wooden flat cars for export to South America.

A 24-stall roundhouse for the Illinois Central is to be erected at Carbondale, Ill., at a cost of $200,000. Plans for the roundhouse have been under consideration several years.

The St. Louis Southwestern has ordered from the Roberts & Schaefer Company, Chicago, two automatic electric coaling plants, to be of reinforced concrete and of 200-tons capacity each. These will be duplicates of the plant that was recently built for the same road at Valley Junction, Ill. The new plants are to be built at Commerce, Tex., and Jonesboro, Ark.

The Great Northern has just placed an order for materials for 296 train order signals. It is their intention to provide standard RSA train order signals on all of the more important main line mileage of the system. The work of installation will be done by the force of the Great Northern. Materials to be furnished by the Chicago Railway Signal & Supply Company. The Great Northern uses RSA standards for all new work, and also for renewals and replacements.

Director General McAdoo has announced the allotment of orders for the construction of 70,000 additional steel underframe freight cars to various car-building concerns on the same basis on which the order was recently placed for 30,000 cars. These 70,000 cars include 15,000 40-ton double-sheathed box cars, 16,000 50,-ton single-sheathed box cars, 15,000 50-ton composite gondola coal cars, 5,000 70-ton low-side gondola cars, 19,000 55-ton hopper coal cars.

The 70,000 cars have been apportioned among the following builders: Bettendorf Co., Bettendorf, Iowa, 3,000; Cambria Steel Co., Johnstown, Pa., 3,000; Haskell & Barker Works, Michigan City, Ind., 8,000; Keith Car Manufacturing Co., Sagamore, Mass., 1,000; Laconia Car Co., Laconia, N. H., 1,000; Lenoir Car Works, Lenoir, Tenn., 2,000; Liberty Car & Equipment Co., Chicago, Ill., 1,000; Magor Car Corporation, Passaic, N. J., 1,000; Mount Vernon Car Manufacturing Co., Mount Vernon, Ill., 4,000; Pacific Car & Foundry Co., Seattle, Wash., 2,000; Pressed Steel Car Co., Pittsburgh, Pa., 14,000; Pullman Co., Chicago, Ill., 8,000; Ralston Steel Car Co., Columbus, Ohio, 4,000; St. Louis Car Co., St. Louis, Mo., 1,000; Standard Steel Car Co., Pittsburgh, Pa., 15,000.

Books, Bulletins, Catalogues, Etc.

Practical Locomotive Engineering, by Frederick J. Prior, 204 Grand Avenue, Milwaukee, Wis. Flexible morocco. Price, $2.25.

This is another addition to Mr. Prior's series of self-educational text and reference books, and worthily sustains the high character of Mr. Prior's publications. In addition to a comprehensive system of the three separate examinations for firemen wherein every question is fully and clearly answered, there are also sections devoted to Locomotive Running, Breakdowns, Defects to Air Brake, and how to remedy them, with a carefully compiled index appended. As is well known there has never been a period in the history of the country when a thorough mastery of the details of the mechanical department is so necessary to those engaged in their construction and manipulation as the present, and this cannot be gained by observation, and the experience of a lifetime may be gained by the careful study of one good book.

Accident Bulletin.

Accident Bulletin No. 63, issued by the Bureau of Statistics, Interstate Commerce Commission, furnishing data in regard to railway accidents in the United States during the first three months of 1917, is at hand, and it is gratifying to observe that, while railroad traffic shows considerable increase, the number of accidents are diminishing. The total number of persons killed—trespassers, employees and others—number 2,213; injured, 17,527. As usual, over 50 per cent of the casualties happened to trespassers. The tables published are restricted to steam railways.

Baldwin Record.

The Baldwin Record No. 90, contains the address delivered by Alba B. Johnson, president of the Baldwin Locomotive Works, Philadelphia, Pa., at the annual convention of the Chamber of Commerce of the United States of America, in Chicago, April 11, 1918. The subject of the address, "The Problem of Motive Power Under the National Administration of Railroads," is not only of vital interest, but the address, coming from such an authority, is worthy the most serious attention. Briefly and strongly the contention is made that standardization can only be applied to details with any degree of permanency, because, in the words of Mr. Johnson, "every improvement in some sense involves the destruction of standardization. It would be an evil day for American engineering and for American progress in the art of transportation which would involve a policy of discouragement to new and useful improvements in the art. We should, therefore, look carefully before we leap, to make sure that we are not giving up the substance of continued growth in efficiency and economy, to grasp the chimera of standardization." The logic of the address is convincing.

Proceedings of the Traveling Engineers' Association.

As intimated in the pages of Railway and Locomotive Engineering last November, the proceedings of the business meeting instead of the twenty-fifth annual convention of the Traveling Engineers' Association was held at Chicago, October 8 and 9, and have been compiled and published by W. O. Thompson, secretary, Cleveland, Ohio. The publication extends to 120 pages, and presents a full report of the meeting including an excellent address by the president, B. J. Feeney, who dwelt particularly on the need of training in fuel economy and a general call to greater activity in the way of assistance to the Council of National Defense. The reports of special committees on the following subjects are printed in full: "What is the best method of keeping engineers and firemen up to date on modern equipment and methods?" "What are the best mechanical devices for smoke prevention in locomotive operation?" "Difficulties of lubricating the locomotive of today." "The locomotive furnace." The latter report is fully illustrated and the subject is exhaustively treated by J. T. Anthony, of the American Arch Company. Lists of committees on special subjects for discussion at the next annual meeting, and also a list of the membership, which now numbers 1,076, is also given. Copies of the publication may be had on application to the secretary, care of general offices, N. Y. C. R. R., Cleveland, Ohio.

Storage of Bituminous Coal.

The Engineering Experiment Station of the University of Illinois has just completed a study of the problems involved in coal storage and has published the results in a 200-page illustrated book designated as Circular No. 6, "Storage of Bituminous Coal." The study was made under the direction of H. H. Stoek, professor of Mining Engineering. The reasons and advantages of storing coal are given, the kinds and sizes of coal which may be safely stored are described, and the many factors entering into successful storage are discussed. Copies of Circular No. 6 may be had by addressing the Engineering Experiment Station, Urbana, Ill. The price is 40 cents per copy.

Coal Prices and Bulletins.

Publication No. 4D, 1918, published by the United States Fuel Administration, Washington, D. C., furnishes in detail the coal prices at the mine, which came into effect April 22, 1918. The prices range from $1.95 per ton for Indiana bituminous run of mine coal, to $5.30 per ton for Pennsylvania Lykens Valley anthracite coal, and to this price may be added 35 per cent per ton allowed to compensate the operators for the increase in wages granted to the mine workers.

The Administration is also preparing a series of official bulletins on engineering phases of steam and fuel economies. Some of these are now ready for printing. They will include: Boiler and Furnace Testing, Flue Gas Analysis, Saving Steam in Heating Systems, Boiler Room Accounting Systems, Saving Steam and Fuel in Industrial Plants, Burning Fine Sizes of Anthracite, Boiler Water Treatment, Oil Burning, Stoker Operation.

In addition to this service, a list of competent engineers has been prepared in Washington for each State and is available for use of each local administration. As the work develops, still further constructive assistance is contemplated for helping owners to bring their plants up to a high plane of economic operation.

Car Utility.

The May issue of *Car Utility*, edited by Bruce V. Crandall, is devoted to freight car construction, and is peculiarly pertinent and timely. It reproduces in its entirety an editorial on the subject from RAILWAY AND LOCOMOTIVE ENGINEERING, March, 1918. Briefly, it conclusively proves that no car should be built with a bottom which is incapable of dumping a dumpable load, or which is incapable of carrying more than one class of freight. Twelve illustrations illuminate the text, and a careful perusal of the interesting periodical shows that one car can be made to do the work of two with little addition to the cost of the car, while the cost, particularly of unloading, can be reduced to a negligible quantity. As an example a general service car for the transportation of cattle, fitted with drop bottoms, securely locked, may be used for the carrying of coal. Thus cattle one way and coal the other would be doing double work.

Statistics of Steam Railways.

An abstract of steam railways in the United States for the year ending December 31, 1916, has been issued by the Government Printing Press, the material for the larger volume containing complete details being in preparation. From the abstract before us it appears that at the date mentioned the miles of road, not including second, third, fourth, or yard tracks and sidings, amount to 259,716.18 miles, and the grand total, including all tracks, 397,014.32 miles. The number of roads represented are placed at 854, the number of operating, switching and terminal roads not covered by the statement being 209. The number of steam locomotives in service were 63,738, and of other than steam, 335. The number of freight cars of all classes amounted to 2,342,699. Passenger train, exclusive of cars in the service of the Pullman Company, 55,081. Of company service cars there were 99,665. The number of employes of all classes were 1,700,814.

Railroad Regulations.

The War Trade Board announces that they had adopted as a part of their rules and regulations the regulations of the United States Railroad Administration in accordance with the proclamation of the President of the United States that all articles of commerce shall require an export license from the War Trade Board for exportation by any port or border point to whatsoever destination, except to points in the non-contiguous possessions of the United States. For status of Canadian shipments, a list of articles require individual licenses.

Electric Lighting.

The illuminating engineers of the Edison Lamp Works of the General Electric Company have prepared Bulletin No. 43,-410 containing the latest information as to the correct methods of lighting industrial plants. The Bulletin is well illustrated, showing various lighting schemes most suitable for industrial purposes, and the facts are brought out that to conserve the employees' health, to save coal, to increase the output and to keep the workers contented, it is necessary that a shop be well illuminated according to modern methods.

Loco.

The quarterly periodical, *Loco*, published by the Locomotive Club, Schenectady, N. Y., issued last month, has an interesting article on "Old Engines." The subject is not new. It comes round periodically like the hay fever and the hives, but the story is told in a new way, that is engaging and also historically correct. The illustrations are not as clear as they might be, but looked at in the light of other days, the dimness is becoming to them. Among other articles, "The Apprentice Department of the American Locomotive Company," is up-to-date, and is well worthy of persusal by those interested in the best methods of training apprentices.

Reactions.

The Metal and Thermit Corporation, 120 Broadway, New York, in their quarterly issue of *Reactions*, describe and illustrate a number of thermit welds successfully accomplished around the railroad shops. They embrace frames, end sills, wheel centers and other fractures, and the descriptions are given by the welders themselves, and hence are of real value in showing what is really capable of being done in every-day practice. Copies of the publication may be had on application to the company's main office, New York.

Against the Metric System.

The National Association of Manufacturers at the final session of its convention in New York recently adopted resolutions condemning the recent revival of agitation to introduce the metric system into the United States. Their decision follows, and is based upon Great Britain's rejection of the same plan after investigation by the British Committee on Commercial and Indutsrial Policy after the war.

Proceedings of the American Railway Bridge and Building Association.

The report of the proceedings of the annual convention of the American Railway Bridge and Building Association, which was held at Chicago in October, 1917, as now published in a volume of 300 pages with numerous illustrations. Copies of the volume may be had from C. A. Lichty, secretary, 319 West Waller Avenue, Chicago, Ill. Price, one dollar.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXI — 114 Liberty Street, New York, July, 1918 — No. 7

Electrification of the New York Connecting Railroad and Hell Gate Bridge

The so-called Hell Gate bridge, the line on which has been recently electrified, is the greatest arch bridge so far built, having a span of 995 ft. 1⅜ ins. between centers of bearings and 1,017 ft. between faces of abutments, and a total height of 305 ft. above mean high water. It carries four railway tracks on a heavily ballasted floor. Apart from its great span and capacity, its principal features are the exceptional size and weight of its individual members and riveted connections, the use of special high-carbon steel, the unusual method of erection, and the monumental towers forming the abutments, one of which rests on a deep and difficultly made and placed pneumatic caisson foundation. Among the details of special interest are the compact closed section of the main arch, the extraordinarily rigid bracing, the efficient latticing of the compression members, the full splicing of the compression joints and the provision for heavy "braking" girders to relieve the floor beams from stress caused by the braking and friction forces. The design was governed by rules and specifications specially prepared by the consulting engineer, Mr. G. Lindenthal, and among their original features is a new formula for impact which, in combination with apparently high permissible unit stresses, is applicable to the design of bridges of any length of span or any capacity, and secures in each case a well-proportioned structure.

HELL GATE BRIDGE, OF THE NEW YORK CONNECTING RAILROAD.

The rather startling name applied to the narrow pass in the East River at New York began its career as a mild and quiet term. It comes from a Dutch (Holland) word "Hellegate," the translation of which is "bright strait" or "clear opening." The Anglicized form, which is somewhat similar in sound to the original name, was applied to the strait on account of whirlpools which made navigation at this point difficult if not actually dangerous, and the latter, misinterpreted name has stuck. The New York Connecting Railroad, built and owned jointly by the Pennsylvania and the New York, New Haven & Hartford Railroad Companies, forms an important link in the heart of Greater New York between the existing railroad lines of these two companies. It is used both for freight and passenger service, separate tracks being provided for each. The connection with the New Haven is at Port Morris and the connection with the Pennsylvania Railroad for passengers is at Sunnyside Yard on Long Island, and from this point trains are run to the Pennsylvania Station, New York, through tunnels. The two-track freight line extends from the New Haven at Port Morris to Fresh

Pond Jct., thence over the Long Island Railroad to Bay Ridge, from which point a short car ferry (about three miles long) completes the connection with the Pennsylvania's freight terminal at Greenville, N. J., on New York Bay. Formerly, the interchange of a few passenger trains between the Pennsylvania and the New Haven Systems was by a car ferry route of about 11 miles from Jersey City to Harlem River and the freight interchange was by a still longer ferry, about 13 miles, between Greenville and Oak Point. As these float services were conducted by the New Haven Road, the New York Connecting Railroad, which takes their place, is operated entirely by the New York, New Haven & Hartford.

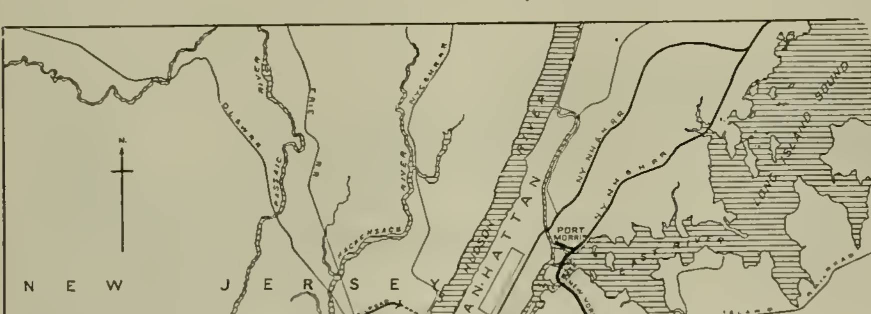
For satisfactory operation in connection with the New Haven Railroad's electric passenger service between New York and New Haven it was decided to electrify the passenger tracks of the New York Conneeting Railroad so that through trains may be operated into the Pennsylvania Station in New York, without changing engines. This electrification has been carried out by the single-phase, overhead catenary trolley system with the same operating characteristics as those employed on the New Haven Road, the current delivered being at 11,000 volts and 25 cycles. The New Haven passenger locomotives used in this service are of the A.C.-D.C. type and are, therefore, capable of operating through the East River Tunnels, which are equipped with third rail into the Pennsylvania Station, the change from overhead to third rail operation being effected at the east end of Sunnyside Yard.

Two general types of structures are used for supporting the overhead catenary trolley. Where it can be used, the Pennsylvania Railroad style of tubular pole has been adopted. On the steel viaduct either side of Hell Gate, the bridges are supported on heavy double brackets riveted directly to the girders underneath the track. As most of these supports are at expansion joints between the deck girders, it was necessary to separate these brackets in order to provide for expansion and obtain satisfactory widths of bearing. The bolts on one side of each post fit into slotted holes to allow for movements due to temperature changes. Within Hell Gate Bridge the trolleys are supported by cross-wires attached to the steel members of the bridge, making a very light, inconspicuous system, and not detracting from the artistic form of the bridge.

The trolley is insulated from the structures by three 10-in. free swinging porcelain discs, similar to those used in the yards of the New Haven Railroad. An insulator arrangement of this kind has the advantage of economy, ample strength and, most important of all, it provides insurance against interruptions to service due to the failure of any one insulator. The height of the contact trolley above the top of rail on and between Bronx Kill and Hell Gate Bridges is 18 ft. because of overhead structural clearances within the bridges. On either side of these points the trolley rises to a normal height of 22 ft. above the rail.

At each signal bridge on the viaduct, circuits have been run between the signals and relay boxes which are on top of the concrete piers and against the steel girders. Access has been provided to the relay box by means of ladders and platforms. The rails used on the New York Connecting Railroad are the Pennsylvania Railroad standard 125-lb. steel rail. Each joint is bonded with two No. 1/0 duplex pin-terminal bonds, similar to those used on the New Haven Railroad, except that the thickness of web in the extra heavy rail required a slightly longer terminal.

TUBULAR POST AND TROLLEY WIRE SUSPENSION.



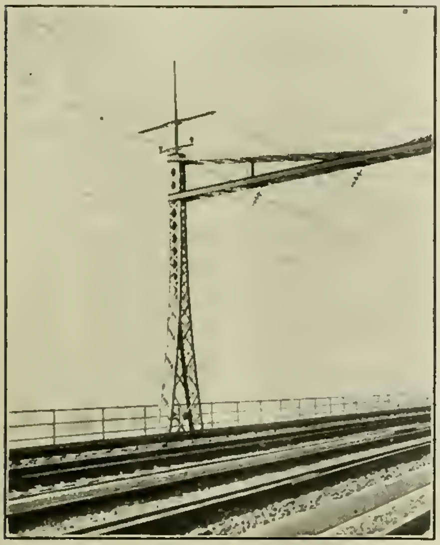
MAP OF THE ROUTE OF THE RAILWAY SHOWING POSITION OF BRIDGE.

For the purpose of railroad communication, a telephone and telegraph conduit line has been built connecting with the Pennsylvania Railroad at Sunnyside Yard, and the New Haven Railroad at East 132d St. between Harlem River and Port Morris, with connections into the railroad towers and to numerous telephones on the railroad.

In the steel splicing chambers on the viaduct the telephone cable has been offset to allow for expansion and contraction of the steel girder, which amounts to about three-quarters of an inch. On Hell Gate and Little Hell Gate Bridges, however, the maximum expansion in the bridge system will be about 10 ins. and here the cable has been terminated with potheads and flexible rubber insulated cables used for connection between the potheads. South of Sunnyside Junction a similar cable has been run along the freight line to Bay Ridge.

Length of two-track passenger line, Port Morris to Sunnyside Yard, 5 miles. Length of two-track freight line, Port Morris to Fresh Pond Junction, 8 miles. Length of two-track freight line, Port Morris to Bay Ridge, 20 miles. Maximum grade westbound, approaching Hell Gate Bridge, two miles, 1.2 per cent. Maximum grade eastbound, approaching Hell Gate Bridge, 1.7 miles, .72 per cent. Length of four-track passenger and freight section, Port Morris to Sunnyside Junction, 3.8 miles. Length of Hell

Gate Bridge between abutments, 977 feet. Length of Hell Gate Bridge outside of towers, 1,150 feet. Clear height of bridge above mean high water, 135 feet. Cost of Hell Gate Bridge, $4,000,000.



TROLLEY BRIDGE ON VIADUCT WITH LATTICE POST.

Cost of the New York Connecting Railroad, $30,000,000. Total cost of line, including the Bay Ridge Improvement, $40,000,000.

Æsthetics of Bridge Design.

A very interesting pamphlet on this subject has been written by Dr. J. A. Wadell, a consulting engineer in New York. He deals with the harmony and beauty which are now considered as part and parcell of good bridge designing. There is no work of man which can add to the beauty of a landscape like a bridge, harmonizing with its surroundings and by its regular lines, bringing out the varieties and vagaries of a sylvan scene. The lines of nature are irregular, those of a bridge are regular. That does not mean that bridge lines are always straight, for a top cord with a parabolic curve is at times most pleasing to the eye.

Dr. Wadell insists that to secure harmony between the structure and its environment, means the merging of its general outlines with those of the landscape. A bridge likely to be seen from various angles and each point of view yields its own impression. The merging of its outlines can usually be secured by attention to the approaches, by extending the hand rails beyond the structure or by curving the wing walls of the abutments. A small arch or girder span can often be given dignity by lengthening the approach walls or extending the hand rails

There is no feature so pleasing as perfect symmetry in the lay-out of spans. If one can see at a glance the reason for the position and function of all the principal parts and features of a bridge, his sense of fitness will be satisfied, and the general impression will be favorable. On nearer approach, if these impressions are justified or enhanced and the more artistic outlines begin to tell, the more thorough will be the general appreciation of the whole.

The harsh outlines of a cantilever can generally be relieved by making the cords simulate a curve. This feature may be made to effect some economy. In many bridges the otherwise pleasing outline is spoiled by the introduction of massive ornamental portals at the ends, and intrusive towers at intermediate piers. Habit plays an important part in our conception of the proper scale or relation of things. Those proportions, which by long usage we have become accustomed to, we instinctively regard as pleasing and fitting, so that a marked departure from these standards fills us with a vague feeling of disappointment.

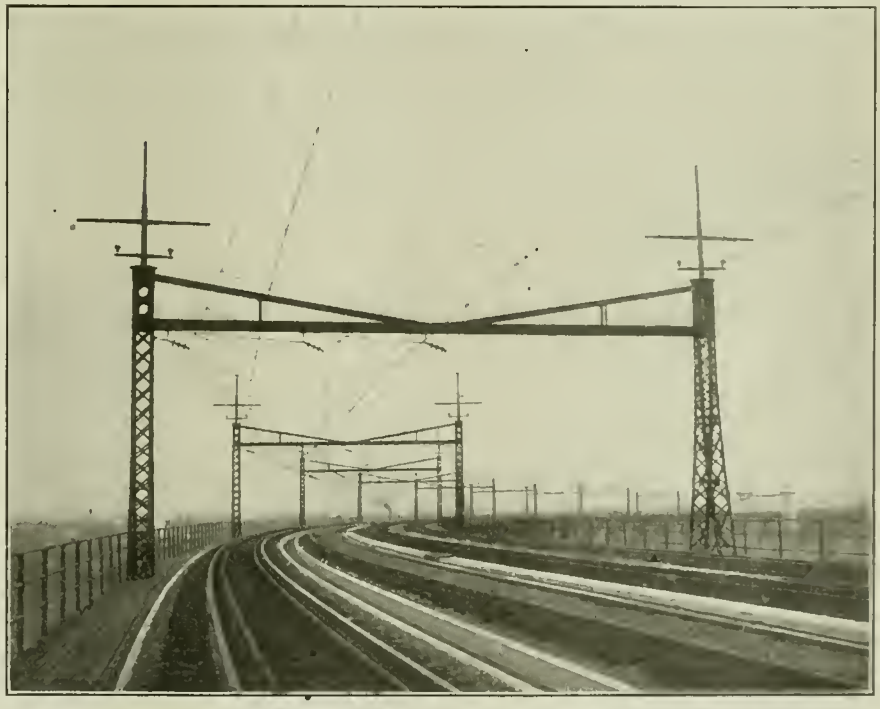
Ornamentation, profuse and overdone, is an aesthetic sin. Properly carried out, to emphasize the function of a member it is completely justifiable and is "good form." If a bridge is forever before a moving throng of people it is well to decorate it becomingly. If the bridge is in a dense forest or sandy desert, and seldom seen, it is folly to spend money on its ornamentation. The ability of any member to do its duty effectively, is a most valuable criterion.

Relieving Railway Congestion.

As a method of relieving congestion on railways, the Council of National Defense in the United States is employing a path-finding automobile to map out a practicable route from a city on the west to the Atlantic seaboard. The route when mapped out will be tested for military transportation by an army truck train, and, if satisfactory, will be adopted as the official route for the transfer of 10.000 trucks to the points for embarkation to France. Besides relieving railways of carrying the trucks, the trucks will be fully loaded with supplies of about 30.000 tons.

Locomotive Headlight Order.

The order requiring locomotives to be provided with high-power electric headlights went into effect on July 1. The Interstate Commerce Commission had extended the date three times since October, 1915. It is not likely that further extensions will be allowed. The order provides that all locomotives produced after that date as well as all that passed through the shops for general repairs shall be equipped with electric headlights, and all locomotives that may not now be in need of general repairs shall be so equipped by July 1, 1920. About two-thirds of the locomotives now in service are already equipped in compliance with the order. The remainder of which, there are about 25,000, will be equipped as rapidly as their need of heavy repairs call them temporarily out of service. The Pyle-National Electric Headlight Company are equipping the new standard locomotive ordered by the Railroad Administration, but the roads are at liberty to use any electric headlight that complies with the requirements of the order.



TROLLEY WIRE SHOWING CATENARY SUPPORTS ON A CURVE.

Installation and Repair of Superheater Dampers

Among the troubles that are to be expected in locomotives equipped with superheater appliances is the gradual change that occurs in the exact opening and closing of the damper which is adapted to prevent the passage of gases when the throttle is closed and there is therefore no steam in the pipes, and to open the passage of the gases when the throttle is opened and the steam flowing through the superheater pipes. An improper installation of the damper in its connections is apt to defeat the purpose for which the device is intended. It can be readily understood that if the damper fails to close properly it will not effectually prevent hot gases entering the large flues when the throttle is closed; and again if the damper does not open properly it will have the effect of a baffling plate in the front end and divert part of the gases, causing poor steaming of the engine, or preventing the desired degree of superheating from being obtained.

When the damper is open, it should stand in such a position that it will be directly parallel to the current of gases flowing through the damper opening. If it does not open far enough, or opens too far, it will have the effect of baffling the gases. The changes in temperature also, in some cases, have the effect of warping the damper, which influences the correctness of operation. The bearing parts wear, and the occurring lost motion has a pernicious effect on the efficiency of the locomotive. This wear, as may be expected, is cumulative, so that damper rigging which was originally correctly installed, may cease to give the proper damper opening. Fig. 1 illustrates this condition, and is based on the assumption that there has been a total wear of ¼ in. in the various pins. This is about the amount of wear that might be expected in a damper that has been in service for a couple years. The effect of the wear is to decrease the damper opening, which diminishes the volume of gases passing through the larger flues, as the angle at which the damper stands offers more obstruction to the passage of the gases.

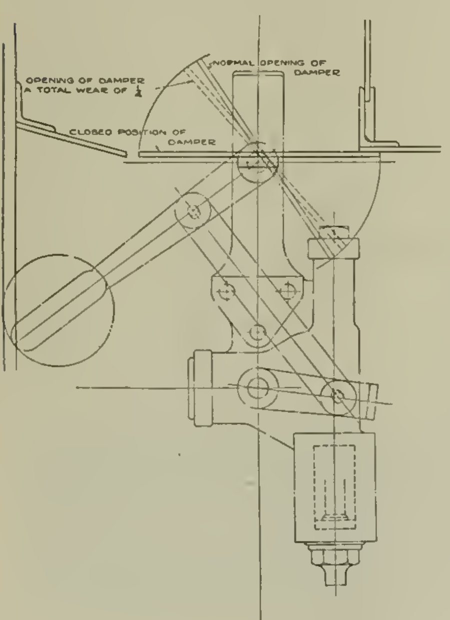


FIG. 1. DAMPER CONDITIONS WITH A TOTAL OF ¼ IN. ON PINS AND BEARINGS.

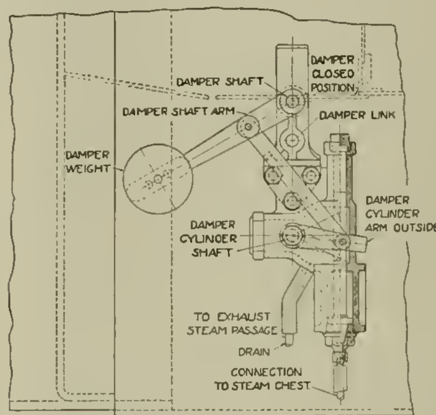


FIG. 2. DAMPER CLOSED, DETAILS OF RIGGING AND METHOD OF PIPE LAGGING.

Apart, however, from the tendency to fall away from the original position at which the damper may have been adjusted, much of the troubles occurring to the appliances arises from the fact that in adjusting the link arm it not infrequently happens that the arm may have been too long or too short to suit the exact requirements of the situation. This has been discovered to be the case in many instances, and the Locomotive Superheater Company has carefully prepared a rule for the proper adjustment of the appliance, and which is well worthy of the attention of those who may be engaged in installing the devices, or in refitting the parts:

After the damper is in place, clamp it in the closed position. When the damper cylinder is bolted in place, the outside cylinder arm should be so located that the centre of the outside pin holes is ½ in below the centre of the cylinder shaft. Place the damper shaft arm on the shaft, connect the link between the outside cylinder shaft arm and the damper shaft arm, and place the counterweight on the latter. The damper is now closed, and the piston should be at the bottom of the cylinder. Lay off, drill and drive into place the ⅜ in. pin which connects the damper shaft arm to the damper shaft. Operate the damper cylinder, either by steam or air pressure, or by pushing the piston to the upper end of its stroke by means of a rod, and then check up the damper opening to see that the damper is approximately parallel with the direction of the flow of the gases through the opening. If this is not the case, adjustment should be made until the correct amount of opening is obtained.

In some cases, it is impossible to locate the damper cylinder on the bracket provided on the outside damper shaft bearing. It then becomes necessary to place the cylinder forward on the smoke-box, and use a long connecting link. In such cases the outside cylinder arm is so located on the cylinder shaft that it travels the same distance on either side of the vertical centre line through the damper cylinder shaft. The damper shaft arm, to which the link is connected, is located in the same relation to the centre line of the damper shaft. In such cases the counterweight may be attached, either to the damper shaft or to the damper cylinder shaft, according to the restrictions placed on the installation by clearances and obstructions on the locomotive. Care should always be taken to see that the counterweight is of the correct weight. A weight that is too heavy will cause an excessive blow on the damper and damper cylinder cover, and may break the cylinder, or the cover, or spring the damper. A weight that is too light will not provide positive closing of the damper. Provision is made in the damper shaft arm by extra holes, for adjusting the weight on the arm.

A word may be added in regard to the effect of climatic conditions on the appliance.

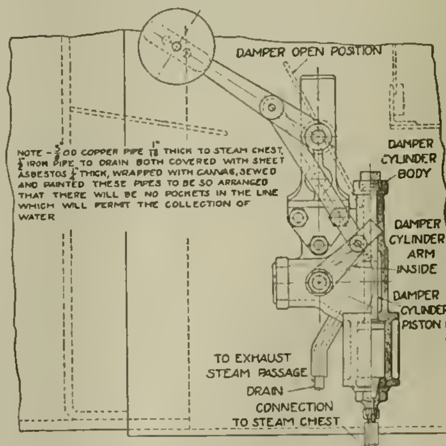


FIG. 3. DAMPER OPEN, DETAILS OF RIGGING AND METHOD OF PIPE LAGGING.

In cold weather, the damper cylinder may become inoperative due to moisture collecting and freezing in the steam and drain pipes, unless these are properly pro-

tected. Figs. 2 and 3 show a desirable practice for arranging and lagging these pipes. Particular care should be taken to see that the pipes are so arranged that they will not contain pockets at any point which would permit moisture to collect and freeze.

The steam pipe should be ⅝ in. O. D. copper, 1-16 in. thick, and the drain pipe ½ in. standard iron pipe and both covered with lagging at least ¼ in. thick. The drain pipe should be connected at its lower end to the cylinder saddle exhaust passage. The piston should always have a tight seat on the upper end of the cylinder when the damper is open in order to prevent leakage as far as possible.

Care should also be taken to connect the damper cylinder steam pipe above the oil supply pipe to the steam chest. If this connection is made below the oil pipe connection oil will be carried into the damper cylinder and is likely to so coat the piston and cylinder walls with gum and other deposits that the cylinder will become inoperative.

Figs. 2 and 3 also show the general arrangement of the damper rigging, with the cylinder shown partly in section so as clearly to indicate the relative positions of the various parts.

It may be added that among the latest methods of maintaining a correct adjustment of the parts, as lost motion is likely to occur between the end of the inside damper cylinder arm and the end of the slot in the piston rod, the end of the arm may be built up, and if necessary, the slot, by means of oxy-acetylene or electric welding. This is a ready and reliable method of maintaining the correct adjustment.

Tenth Annual Convention of the International Railway Fuel Association

Digest of Important Papers Submitted—Election of Officers

Not very long ago the most important convention of the International Railway Fuel Association yet held took place in Chicago, Ill. Indeed it might be truly said that the meeting marked the beginning of a vigorous campaign for the conservation of coal by all the railroads in the country, and to promote the production of more and better coal at all mines. The convention was held under the joint auspices of the United States Railroad Administration and United States Fuel Administration. Mr. E. W. Pratt opened the proceedings with an able and eloquent address pointing out the pressing need of continuing the conventions of the Association as the necessity for fuel economy was greater than ever during the war, and their decision had met the approval of the Federal government. Mr. Pratt pointed out that it took a million more coal cars to haul about 50 million tons of slate and rock from the mines to the users, a tremendous loss in economical firing due to ashes and clinkers, and another million cars to haul them away. The miner might say that it would give him less earnings during the year to pick the coal well and the operator might say it would give him less sales for the year, but this is not true. The output of both miners and the mines will without doubt this year be the car supply at the mines, as has been the case for the last few years; and it should be borne in mind that the railroads are not responsible for this condition, but the public policy towards them for the past decade. Twenty-seven per cent of the coal which is used by the railroads is so large that we hope by care and close attention to details, not only as to firing, but better repair of locomotives, more care in dispatching and moving trains and better operation on the part of the engineer, to save millions of tons of coal and millions of gallons of fuel oil; for be it remembered that there are several thousand locomotives in this country burning oil.

Superheating has been proved practicable and each locomotive so equipped saves hundreds of tons of fuel per year besides rendering faster and better service; hence the present practice of superheating the larger locomotives passing through the shop should be continued as far as possible. The locomotive feedwater heater also offers an attractive field for economy and efficiency and well warrants careful and continued experimentation. Mr. Pratt closed by stating that it has been said, "Ships will win the war", "Food will win the war", "Coal will win the war"; but I tell you it is individual effort that will solve the fuel problem and thus render its great share in winning this war for democracy."

Mr. P. B. Noyes, Director, Distribution Division, United States Fuel Administration, stated that the solution of the war fuel problem is a task quite beyond the power of any administration or administrator. It lies in the hands of a thousand agencies and millions of men. The coal supply is short, and the requirements for war purposes threaten to make it shorter still in the coming winter. Every ton of coal saved means the employment or non-employment of a hundred men, because fuel is a small part of the raw material of most manufacturing institutions, but this part is vital. Without it the factory closes. If you remember that railway locomotives burn more than a quarter of all the coal mined in the country, you will not accuse me of exaggeration when I say that it is in your power and in the power of the railway firemen and the organization with which he works to save enough coal to turn threatened national disaster into national prosperity. I appeal to the railroad superintendent, the firemen—every man who has a hand directly or indirectly in producing or consuming the one hundred and sixty million tons of railway coal—to do each his work the very best he knows how, and this convention will have accomplished more of real value than a world of instructive technical papers or discussions.

Mr. Robert Quayle, General Superintendent, Motive, Power and Car Department, Chicago & Northwestern railway, also dwelt on the need of intense earnestness on the part of every man of the two millions of railroad men, to work together as one man, each helping the other to the one end of saving fuel, then we could easily save ten per cent, which would mean a saving of 17,500,000 tons, or $43,750,000.00. The master mechanics should be in touch with the division superintendents and train dispatchers, so that they should feel and know what they are personally being interested in.

It is the master mechanic's duty to be so in touch with his shop men, and engineers and firemen, that they will have confidence in him, and he should have the happy faculty of having the men constantly feel kindly toward him. This would enable him at once to get the best from the men that can be had, bearing in mind that because a man fills a lower position than the master mechanic, that he is no less a man, and might be a whole lot bigger with the same opportunities. The duties of the roundhouse foreman are multitudinous. He has to see that the men are there on time, has to see that his engines are out on time, has to look over the reports, and see that everything is properly done.

We require a good deal from the roundhouse foreman, and to be a successful roundhouse foreman, to get the very best

out of his job, he should be gracious, he must needs be a philosopher, he must be a student of human nature, he must smile when everything goes "dead wrong." The engineers and firemen also have opportunities to save fuel. They are doing much and they will do more. We should all think more deeply, work a little harder, fight a little harder for the conservation of fuel and for the Government by which we are employed.

Mr. W. S. Carter, Director, Division of Labor, presented a clear and comprehensive vision of the great struggle in which America is engaged and closed by stating that when our children's children read these stories of the part played by Americans in the great war for Liberty, they must find there also recorded that the railroad men of America, realizing that upon them had fallen the burden of transporting troops, munitions and food far beyond their normal capacity, worked as no men had ever worked before, and thereby had maintained an uninterrupted medium of transportation, without which the war could not have been won.

Mr. Frank McManamy, Division of Locomotive Maintenance, presented an able and instructive paper on "The relation of Locomotive Maintenance to Fuel Economy", in the course of which he pointed out that without well-studied, well-balanced design, locomotive maintenance alone cannot effectuate either fuel economy or operating efficiency. The inventor has done great work with the result that the super-heater, the brick-arch, the combustion chamber firebox and other fuel-saving devices are today parts of the equipment of every modern locomotive. The influence of these devices in effecting real fuel economy is tremendous, and their applications to many existing locomotives will result in a marked reduction in fuel consumption. Frequent and thorough boiler washing is the foundation of proper boiler maintenance, and this has been recognized in all boiler inspection rules, both state and national. Authorities differ somewhat as to the exact loss due to scale on the boiler sheets, but a comparison of tests made indicate pretty conclusively that 1/16 of an inch of scale will increase the fuel cost approximately 15 per cent and that 1/4 of an inch of scale will increase the fuel cost approximately 60 per cent.

Some of the repairs which will do the most toward reducing fuel consumption and improving locomotive performance, arranged in what is belived to be the relative order of their importance, are: setting the valves properly and maintaining the valve motion, washing the boilers, keeping the flues clean, eliminating steam leaks about cylinders and steam chests, and maintaining the driving boxes and rods.

In the conservation of fuel by better locomotive maintenance, as in all other matters relating to transportation, the United States Railroad Administration and the railroadmen of the country who are solidly behind it can rightfully adopt as their motto, "We will deliver the goods".

Mr. Thomas Britt, Railroad Fuel Agent, Canadian Pacific Railway, in the absence of Sir George Bury, who was unable to be present, made a forceful appeal for an earnest and united effort, and impressed the meeting with the truth of the fact that the successful prosecution of this war depends upon no single industry—upon no group of resources. At the same time all the resources of a nation are worthless without adequate transportation facilities. There is scarcely an industry, that we can think of, that is not ultimately at the absolute mercy of the railroads. They link together the scattered centers of a mighty continent, and thus permit all to share the various products of each. Coming to the question—what are we doing? The most drastic feature of our programme has been the reduction in passenger service with a simultaneous increase in freight traffic—this, of course, as a matter of sheer necessity to meet war requirements. In the handling of freight we are seeking to apply the well-established principle, that the greater the speed, the greater the consumption of coal. Hence fast freights are by no means a desireratum. In addition we have endeavored to run our freights at full capacity tonnage, thus securing the maximum results with the minimum fuel consumption. Another feature of fuel conservation is the elimination of needless delays by a careful arrangement of schedules and rapid despatching.

Mechanical devices such as superheaters, automatic fire doors, etc, may accomplish a great deal in the matter of avoiding unnecessary wastage, but certainly the human element is the dominant factor—we cannot get away from it. Give us a body of expert and conscientious firemen, and I dare say the problem is solved. In the matter of detail gas-house coke can be utilized for heating stations. Scrap wood can be used in shop boilers, old ties can be gathered up and burned for the same purpose. In wooded districts, if we stop to consider that one cord of hard wood is equivalent to a ton of coal, it is easily understood that, for every cord of wood so substituted a ton of coal is released for use in war work. We might more earnestly ask in exchange for our share in this worthy enterprise that our railroads be not overburdened any longer with a lot of foreign matter under the guise of coal. I myself have found it necessary to have whole carloads of this extraneous matter dumped into the ditch, it being absolutely worthless as fuel for any purpose. There is certainly no conomy that can ever be found there.

The overloading of tenders has been the cause in the past of an incalculable waste. Thousands of tons have been lost by thus scattering coal along the highway. Measures have been taken to avoid this frightful deficit, and yet observation along the right-of-way of our railroads would indicate that there is still room for improvement.

"Fuel Oil and the War", furnished a topic for Mr. M. L. ReQua, Director Oil Division, who pointed out that the normal increased consumption of fuel oil for the year 1918, based upon the average increase over a period of fourteen years, will approximate something over 20,000,000 barrels. An abnormal increase, due to war conditions, will probably very greatly add to this amount. We are, therefore, faced with the necessity of handling a tonnage considerably in excess of last year, viewed solely from the standpoint of railroad transportation. If coal were available it would be highly desirable that the use of oil be discouraged wherever possible; but unfortunately conditions governing the supply of coal are also acute. We are stating the problem, therefore, from the viewpoint of the oil division of the Fuel Administration, in the hope that, if conditions make it possible, the substitution of coal for oil may be made wherever practicable.

A campaign of education for the prompt unloading of tank cars by the railroad shops is very urgent. Motive power departments particularly have a habit of partly unloading a tank car at one shop, then switching it to another division point for further unloading. In this way they are responsible for the outrageous abuse of tank cars of private ownership.

Among others who contributed papers were Mr. John P. White, Labor Advisor; Mr. Eugene McAuliffe, Manager, Fuel Conservation Section; Mr. Harry N. Taylor, Vice-president, Central Coal and Coke Company, Kansas City, Mo., and Mr. Claxton E. Allen, Deputy Fuel Administrator of Illinois.

All of them dwelt strongly on the absolute need of the strictest economy in the use of fuel, and the suggestions offered will appear in full in the published report of the meeting which will be issued at an early date, and which will be distributed to all the railroad centers and other industries.

The following officers were chosen for the ensuing year: President, L. R. Pyle, Soo Line, Minneapolis, Minn.; vice-president, J. B. Hurley, Wabash Ry., Decatur, Ill., and H. B. McFarland, Santa Fe, Chicago; secretary-treasurer, John G. Crawford, Burlington Ry.; executive committee, E. W. Pratt, R. R. Hibben, W. H. Averell, B. Pemberton Phillippee, T. D. Smith, A. N. Willsie, W. D. Arter, W. J. Bohan, H. B. Brown, L. J. Brown, L. J. Joffray and H. Woods.

Mallet Articulated Locomotives for the Baltimore & Ohio Railroad

In the spring of 1916, the Baltimore & Ohio received from the Baldwin Locomotive Works fifteen Mallet locomotives of the 2-8-8-0 type. These engines were placed in road service on the Cumberland Division, handling heavy coal traffic over maximum grades of 2.4 per cent. A proof of their efficiency is found in the fact that thirty additional locomotives of similar design were subsequently ordered and are now being placed in service. One of the new engines, No. 7135, is illustrated on this page.

This design of the engine specially fits it for road service, it has a truck at the front end only. The maximum curves which the locomotives traverse are of 22 degs. radius, and the tractive force exerted is 103,000 lbs. Sustained horsepower is necessary in handling heavy tonnage over the long mountain grades on which these engines work, and careful attention has been given the boiler design in order to provide ample steaming capacity. The boiler has a grate area of 88.2 sq. ft., a water heating surface of 5,819 sq. ft. and a superheating surface of 1,415 sq. ft. These figures appear impressive when it is recalled that the heaviest freight locomotive used on this road twenty years ago had a total heating surface of 2,331 sq. ft. and a grate area of 33.6 sq. ft. This locomotive was of the Consolidation type, weighing 172,000 lbs. and using saturated steam.

The Mallets have conical boilers, 90 ins. in diameter at the front ring and 100 ins. in diameter at the throat. The firebox is placed above the two rear pairs of drivers, and has a combustion chamber 60 ins. long, extending forward into the boiler barrel. The firebox crown slopes 3¾ ins. from front to back, this slope being approximately parallel to the water level when the locomotive is descending a grade of 2.4 per cent. The firebox equipment includes an arch, power operated grate shaker, and Street mechanical stoker. The ash-pan has three hoppers, and is fitted with cast iron slides working in cast steel frames. The shell plates used in this boiler are heavy, those in the third and fourth rings being 1 1/16 ins. thick. The middle seam in the barrel, and the seams uniting the throat, outside firebox shell and fourth ring, are triple riveted.

The superheater is arranged with 48 units. There are 2 outside steam pipes, placed right and left, connecting the superheater header in the smoke-box with the high-pressure cylinders; and a single flexible receiver pipe connecting the high and low pressure cylinders. The starting-valve is placed in a pipe which connects the left-hand high-pressure steam pipe with the receiver pipe. When the throttle is first opened, and there is no pressure in the receiver pipe, this valve, which is fitted with a differential piston, is open, allowing live steam at reduced pressure to pass direct to the low pressure cylinders. As soon as the receiver pressue builds up, due to the high-pressure exhaust, the starting valve closes, by reason of this increased pressure acting on the large end of the differential piston; and the locomotive works in compound at once. Should the starting-valve for any reason fail to operate, steam at boiler pressure can be admitted against the piston through a valve in the cab and a suitable pipe connection.

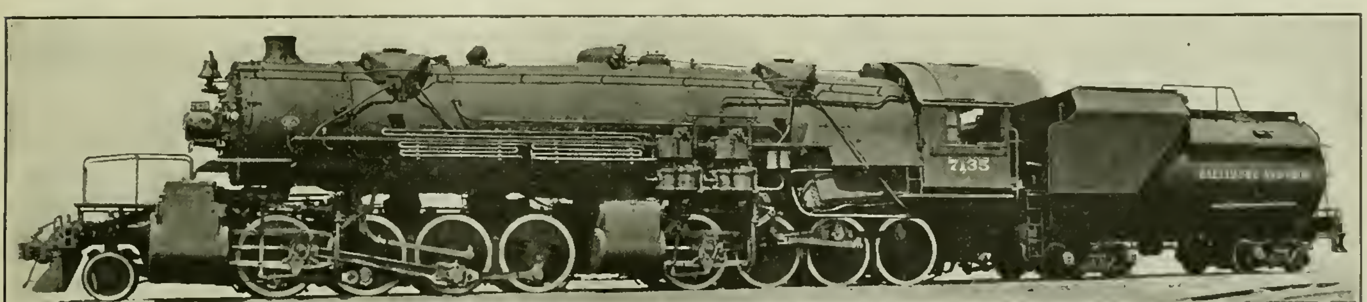
The high-pressure distribution is controlled by 14-in. piston valves, and the low-pressure by Allen-ported balanced slide valves. A force-feed lubricator is used, with one feed to each high-pressure cylinder, one to the receiver pipe, one to the starting valve and one to the air pumps. Walschaerts valve motion is employed, and the gears are controlled by the Ragonnet power reverse mechanism. The low-pressure cylinders are set on an inclination of 1 in 39, in order to allow sufficient clearance above the rail.

The frames are annealed carbon steel castings, 5½ ins. wide, and spaced 41 ins. between centers. The articulated connection between the front and rear frames is designed to provide flexibility in a vertical as well as a horizontal plane. The radius bar which forms this connection, is attached to the front frames by a horizontal pin, and has a ball-jointed connection with the hinge-pin. The front and rear frames are neither interlocked nor connected by hanger-bolts. In this way these frames are free to move both vertically and horizontally with reference to each other, without binding at the articulated joint. This construction is regularly used on Baldwin Mallet locomotives.

The boiler is supported, on the front frames, by two waist bearers. The upper section of each bearer is fitted with a brass shoe, which slides on a steel plate. This plate is mounted on the lower section of the bearer, and its under side is rounded to a large radius; hence the pressure on its upper surface will always be evenly distributed. The liners which are used above the two waist bearers and the high-pressure cylinder-saddle, for the purpose of strengthening the boiler shell, are placed outside the boiler in order to permit caulking.

These locomotives were designed with a height limit of 15 ft. 6 ins. and a width over the low pressure cylinders of 11 ft. 4 ins. To keep within the tunnel clearances, four saddle shaped sand boxes are used, two for the front engine and two for the rear; and they are placed right and left, on the round of the boiler. Sand can be blown under either the front or rear wheels of each group. The bell is mounted on the smoke-box front. Electric headlight equipment is applied and the headlight is mounted on the center of the smoke-box door. The dynamo is placed over the boiler, between the front sand-boxes and main dome. Flange lubricators are applied to the leading drivers of the low-pressure engine.

The tender is of the Vanderbilt type,



MALLET ARTICULATED LOCOMOTIVE 2-8-8-0 FOR THE B. & O.

F. H. Clark Gen. Supt. Motive Power. Baldwin Loco. Works Builders.

and is among the largest thus far constructed, as it has capacity for 12,000 U. S. gallons of water and 20 tons of coal. It is carried on rolled steel wheels and arch bar trucks. The frame is built up, with heavy longitudinal steel angles and cast-steel end sills.

These large Mallets are proving successful under exceptionally difficult operating conditions, because they were specially designed for the service they are in, and are intelligently handled on the road. Their leading dimensions are given in the table.

Cylinders, 26 ins. and 41 ins. x 32 ins.; valves, H. P., 14 ins. piston L. P., balanced slide. Boiler—Type, conical; diameter, 90 ins.; thickness of sheets, 15/16 ins., 1 in., 1 1/16 ins.; working pressure, 210 lbs.; fuel, soft coal; staying, radial. Fire Box—Material, steel; length, 132¼ ins.; width, 96 ins.; depth, front, 89¼ ins.; depth, back, 67 ins.; thickness of sheets—sides, back and crown, ⅜ ins.; thickness of sheets, tube, ½ ins. Water Space—Front, 6 ins.; sides, 6 ins. to 4 ins.; back, 4 ins. Tubes—Diameter, 5½ ins. and 2¼ ins.; material, steel; thickness, 5½ ins., No. 9 W. G., 2¼ ins., 0.125 ins.; number, 5½ ins., 48; 2¼ ins., 269; length, 24 ft. 0 ins. Heating Surface—Fire box, 228 sq. ft.; combustion chamber, 113 sq. ft.; tubes, 5,443 sq. ft.; firebrick tubes, 35 sq. ft.; total, 5,819 sq. ft.; superheater, 1,415 sq. ft.; grate area, 88.2 sq. ft. Driving Wheels—Diameter, outside, 58 ins.; diameter, center, 50 ins.; journals, main, 10½ ins. x 20 ins.; journals, others, 10 ins. x 13 ins. Engine Truck Wheels—Diameter, 33 ins.; journals, 6 ins. x 10 ins. Wheel Base—Driving, 41 ft. 2 ins.; rigid, 15 ft. 6 ins.; total engine, 50 ft. 4 ins.; total engine and tender, 87 ft. 5¼ ins. Weight—On driving wheels, 459,400 lbs.; on truck, 25,000 lbs.; total engine, 484,400 lbs.; total engine and tender, 694,000 lbs. Tender—Wheels, number 8, diameter, 33 ins.; journals, 6 ins. x 11 ins.; tank capacity, 12,000 U. S. gals.; fuel capacity, 20 tons; service, freight.

Estimates on Increased Revenue.

Officers of nearly all the railroads have made estimates which are likely to result from the recent order of the Director-General, increasing freight rates and passenger fares, and also of the increase in this year's expenses following the big wage increase and higher prices for nearly everything entering into operation.

The railroads carrying a large proportion of high-class freight, and coal roads with short hauls will show the highest ratios of gain in freight earnings. On coal and coke, rates up to 49 cents a ton are to be increased 15 cents, that is, 30 per cent or more. Between 50 and 99 cents the increase is 20 cents, or from 40 per cent to 20 per cent; and between $1 and $1.99 the increase is 30 cents or from 30 per cent to approximately 15 per cent. On grain the increase is to be 25 per cent, but not more than six cents per 100 pounds.

Passenger rates, other than commutation, soldiers' and sailors' personally paid fares and certain other special rates, are to be raised to three cents a mile. In addition, to this and the regular Pullman fare, passengers in standard sleeping or parlor cars must pay 16 2-3 per cent of the ordinary train fare for their berths. Commuters are to pay an advance of 10 per cent.

Tentative estimates indicate that the New York Central will get in the neighborhood of $55,000,000 additional revenue from these advances, of which perhaps $21,000,000 or $22,000,000 will come from passenger business

The New Haven Railroad will be one of the principal beneficiaries of the passenger fare advance. Of the 92,000,000 passengers carried by the New Haven in 1917, 16,500,000 were commuters. New England roads, furthermore, were granted certain higher fares two years ago and a general increase early this year. The New Haven should get upward of $10,000,000 a year out of the passenger fare order. The Erie will get something like $2,700,000 from passenger business. This is a gain of about 38 per cent. The Erie's coal business is expected to yield $4,500,000 more than last year and the balance of the $20,000,000 will be from other commodities and merchandise.

The Pennsylvania Railroad officers put the increase in passenger revenue at not more than $8,000,000, or about 15 per cent of the $53,000,000 for 1917.

The Philadelphia & Reading think the increase in passenger revenue at the low figure of $100,000 and the additional freight revenue at $9,000,000. They expect their operating expense, including wages, coal and materials, to run $7,000,000 above 1917 figures.

Railroad men discuss the wage adjustment guardedly, but some have pointed out that a good many alterations are likely to be made as a matter of necessity, which will swell the total increase for all the roads well above $300,000,000, perhaps to $350,000,000. Numerous cases have already come to light in which employees who have had advances since the end of 1915 on account of special diligence and ability obtain little or nothing from the latest wage order.

Launching of Canadian Northern Ferry.

The Canadian Northern Railway car ferry "Canora" has been launched at Point Levis, Que. It is expected that the vessel will be completed and turned over to the company early in July. The "Canora" was built for the transportation of passenger and freight cars between Canadian Northern terminals on the mainland in British Columbia and the Island of Vancouver, completing the transcontinental service of the company from Quebec City to Victoria.

The vessel is, over all, 308 ft.; of moulded breadth, 52 ft., and draught, loaded, of 14 ft. 6 ins. The displacement is 3,400 ft.; service speed, 14 miles, and the capacity, 20 cars. The vessel is constructed on the transverse framing principle, open bottom type and is subdivided into six main transverse water-tight compartments by five water-tight bulkheads. Water-tight doors are fitted for communication between the engine and boiler spaces and shaft tunnel. Water ballast is provided for in peak tanks forward and aft and in trimming tanks on each side of the engine room. The cars are carried on the main or car deck on three lines of tracks, one line of tracks being on the centre line of the vessel and one line is on each side of the centre. Above the car deck at a height of eighteen feet there is a complete shelter deck extending the full length and width of the vessel, and on this deck accommodation for passengers and officers is provided.

The "Canora" will go under her own steam from Quebec to Vancouver via the Panama Canal, forty days being allotted for the voyage.

Speed of Wood-Working Machinery.

It is curious, said a well-known master car builder the other day as we strolled around his finely arranged planing mill, it is curious how ignorant most of your iron working friends are about the speed of wood-working tools. Most of them know that this class of machine requires great power to drive it, and that is due to the enormous capacity of these machines for doing work. Wood, of course, is more easily worked than metals; but the material is cut up so rapidly that it represents immense concentration of power. Here are some notes on the subject that may surprise some of the men who are deficient in respect for the wood workers of the country.

A properly driven circular saw has a periphery speed of 7,000 feet per minute—nearly a mile and a half. A band saw is run at about half that speed. Planing mill cutters have a speed at the edge of 6,000 feet per minute, and the cutters of moulding machines turn out material at about 4,000 feet per minute. Wood-carving drills are run about 5,000 revolutions per minute. Augers 1½ ins. in diameter are run 900 revolutions per minute, and those half that size are run at 1,200 revolutions per minute. Mortising machine cutters make about 300 strokes per minute.

To endure the severe service that wood-working machines perform they must be well made and of excellent material.

Fifty-first Annual Meeting of the Master Car Builders' Association, and Fiftieth Annual Meeting of the American Railway Master Mechanics' Association

In view of the fact that the Executive Committees of the Master Car Builders and American Master Mechanics had both decided that the annual conventions be again postponed this year it was felt that on account of accumulated work of committees and other matters, it was deemed advisable that an annual meeting of the joint executive committees be held in Chicago, Ill., on June 19 and 20. The Director General of Railways approved of the meeting of the associations as proposed and outlined and authorized the carriers to make such arrangements as would meet the requirements of the members in attendance at the meeting. The various committees that were appointed last year had prepared reports on the various subjects assigned to them which will be printed in full as soon as the acting secretary can prepare the matter for publication, and these reports will be distributed among the entire membership of the associations.

It will be remembered that no convention of the two associations was held last year, as the absence of so many of the leading men in the mechanical departments of railroads, even for a limited time was not deemed advisable in view ot the pressing needs of transportation service. At the same time many important subjects of the service were in the hands of committees, and much valuable matter had accumulated in their hands. Hence the decision that the work of the committees should be continued even if it be deemed advisable to temporarily discontinue holding the two conventions. Meanwhile, the Executive Committees will meet at such times as are deemed advisable.

The Executive Committees met in the Florentine Room of the Congress Hotel, Chicago, as announced, and after transacting considerable routine business, the various committees reports were submitted, and generally approved of. A condensed synopsis of the reports is appended, and, to say the least, the continued activity of the work of the associations is a growing necessity that amply justifies the selection of the brightest and best minds of the membership to continue in the good work which they have so long and so faithfully carried on.

PRESIDENT SCHLAFGE'S ADDRESS.

In this passion time of the world, in this greatest of all crises, not only individuals, but every association of individuals, and every agency of human thought and action, especially those intimately related to the vital necessities of the nation's life must pass through a course of searching self-inquiry to determine to what extent the individual, or the association, or the agency is responsive to the full duty that rests upon him or it. In harmony with this thought, it is pertinent to recall that the test of the capacity of any individual or of any organization is his or its reaction to supreme emergencies. This association is an organization purporting to promote the interests of rail commerce in respect, primarily, of mechanical operation and the problems thereto related arising in the conduct of that vast enterprise.

The test then is—"Has this association, with exactly 50 years of experience behind it, so conducted its affairs; has it so impressed itself upon the thought of the railway world; has it so utilized its opportunities that it has in fact achieved the leadership that reasonably and logically could have been expected, so that in the supreme emergency of the nation's need, the director general of the national railways could turn to it as a perfectly organized and efficient instrumentality of railroad work and find in its proceedings solutions of many of the problems that he had to solve, and an active, smoothly running agency to put into effect the conclusions of its experience and to give constructive advice?" Did it so shape its course to render assistance to the end, in sight for many years, of a thorough co-ordination of the transportation business of the country in the interest of its people?

Candor compels the admission that while the association has justified its existence, it has not taken the high place to which it might have aspired. It is only just to say, however, that the limitations upon its proper expansion and development were largely beyond its control because of the general failure of railroad interests to recognize the fundamental principle that the transportation business of a nation is a natural state monopoly and that, sooner or later, a progressive state will either dominate the control of its transportation lines or own them.

To far-seeing men, it has been clear for many years that even peace conditions demanded the nationalization, either under private control or public ownership, of all the transportation agencies of this country. It was, therefore, apparent that standardization of the instrumentalities of commerce, as well as of methods, was inevitable if the highest efficiency were to be attained and the nation be well served according to its constantly growing business expansion. This association practically failed to recognize the ineluctable trend of events so that when, as a necessary war measure, the National Railway Administration demanded a standard locomotive, the association had no standard to offer.

All the voluntary railway associations have failed, more or less, to do the good they might have done for the simple reason that, as units, or collectively, they had no authority to constrain the railroads to the standards they did prescribe. This brings us to the question of the future of the associations.

Both major mechanical associations have been continued by the director general of railroads as railway organizations to the support of which the carriers may contribute. It is obvious that, if the approval is to stand indefinitely, both associations must bring themselves into harmony with the demand that these, and all similar railway agencies, shall be fully co-ordinated under a plan that will insure the achievement of stated and definite ends.

Conceding that co-ordination does not necessarily imply consolidation, it seems, nevertheless, that the logic of the situation might justify an institution to be called, for example, the American Railway Mechanical Association, organized to effect definite and highly useful ends as a unit. The institution of a new organization to cover the field now occupied by two can be effected without impairing the usefulness of either; on the contrary, their usefulness would be increased.

I earnestly commend to the association the wisdom of complete responsiveness to the letter and spirit of the director general's desire that the work of all such organizations be brought into close co-ordination, clearing their conclusions through one central authoritative body which, it is submitted, should be the American Railway Association. There is a growing conviction in many quarters that sentiment is the chief obstacle in the way of consolidation and, however admirable sentiment may be in its proper place, it is scarcely entitled to any consideration here.

It is suggested that a plan can be worked out, using the American Railway Association as the clearing house, whereby the results of all railway experience can be crystallized into settled practice and

whereby the sum of knowledge may be increased and an organization perfected meriting at least a quasi public footing that will be able and qualified to render valuable constructive service to the nation in time of peace as well as war.

Let me urge with equal earnestness the necessity of accepting and in every way encouraging the principle of the standardization of locomotives. There is little merit in the argument that standardization implies the end of improvement and progress. It would and ought to stop ill-advised and ill-considered innovation. By accepting the principle of standardization, and applying it to details of construction, a start will have been made that will rapidly reduce the ranks of those real obstructionists who are always on the job to cover every sign post on the road to progress with the legend "It can't be done."

With the authority of the Government back of this proposition and crediting its proponents with a full appreciation of the value, not to say dire necessity, of locomotive efficiency, may we not safely dismiss all fears that evolution will die a violent death or that any substantial discouragement will be given to American enterprise to continue to apply its genius to keep the development of the locomotive abreast of the improvements that America shall make in all other directions. Also, it should be kept in mind that whatever the ultimate fate of the railroads may be, all signs indicate that they will be operated in the future as a national system and the efficiency of the whole operation rather than of a given portion of it will be the test.

It is quite generally urged that the present is inopportune to take such a radical step on account of the delay it will cause in deliveries. The force of this objection is dissipated by the reflection that the duration of the war is problematical and that the present is the very latest time to take essential steps to guard the future. Standardization of ships and submarine chasers has justified itself—Why not locomotives?

The association has done much valuable work through its various standing and special committees. Many of the more important committees covering assignments of live subjects, such as Fuel Economy and the related subjects of Mechanical Stokers and Powdered Fuel and Superheater Locomotives and Train Resistance Tonnage Rating, as well as the essential committees on Standards and Recommended Practice will be asked, doubtless, to collaborate with agencies created by the National Railway Administration.

All endeavors within the scope of the association's activities are indissolubly joined to the dominant issue of the national defense and it cannot be stated too often that the yard stick by which effort was measured in times of peace is utterly inadequate for application to the quality and quantity of endeavors that America now expects. A whole-hearted responsiveness to the plans and policies of the National leadership is the duty of every citizen, and if more may be expected of any class than of another, it surely may be expected from those like ourselves who are actually in highly essential Government service.

We stand here today in the place of that small group of forehanded men who a half century ago conceived and organized this association. Through all the years that have passed since then, it has held true to its original purposes and ideals. If it has failed in any respect to achieve the commanding position that it might have held, it must be granted that from its pioneer days it has been an active constructive force in its own field. Our faces must now turn hopefully to the future and, with the high inspiration of this stirring age to guide and encourage us, resolutely "carry on" and make up the lost opportunities of the past days.

REPORT OF SECRETARY.

The secretary reported the following membership: Active members, 902; representative members, 98; associate members, 17; honorary members, 45; and a total membership of 1,062. The total receipts during the two years ending June 18, 1918, were $16,308.56; disbursements, $12,809.35, leaving a cash balance of $3,-499.21.

The treasurer reported a back balance of $2,115.50.

Committee Report on Car Wheels.

The committee reporting to the M. C. B. Association on car wheels was composed of Messrs. W. C. A. Henry, chairman; W. Alexander, C. W. Van Buren, J. A. Pilcher, O. C. Cromwell, J. M. Shackford, H. E. Smith, C. T. Ripley, and R. E. Jackson. They said, among other things that the Committee on Standards and Recommended Practice in the 1917 report, had recommended the circumference measure for steel and steel-tired wheels, as shown on M. C. B. Sheet "C," be advanced to Standard for steel, steel-tired and cast-iron wheels, and that the circumference measure for cast-iron wheels, Sheet M. C. B. 16A, be eliminated. This recommendation was submitted to letter ballot and carried, no change being made in the specifications for cast-iron wheels.

Much confusion has arisen as this gauge can not be used in connection with specifications for cast-iron wheels as they now read. In order to meet the situation it was recommended by this committee that the circumference measure for steel, steel-tired and cast-iron wheels be modified on the drawing which was annexed to this report.

The proposed gauge was different from the one heretofore used, in that the length of the band is increased 5 ins. in order to take care of the 38-ins. diameter steel and steel-tired wheels. The markings for steel and steel-tired wheels occupy but half the width of the band, the markings for cast-iron wheels occupying the other half. The latter markings are identical with the past practice, but when required to meet present specifications for cast-iron car wheels, it does not seem practicable to have one set of markings, for the reason that the 36-ins. steel wheel after being turned down and before reaching the condemning limit will sometimes be of less diameter than a new 33-ins. wheel, and, therefore, for use in mating steel wheels a continuous scale is necessary.

Attention is called to certain errors in the specifications for cast-iron wheels.

In Paragraph (b). It shall not exceed 1 in. in the middle of the tread nor be less than 3/8 in. in throat for wheels having a maximum weight of 625 lbs.

In Paragraph (c). It shall not exceed 1 in. in the middle of the tread nor be less than 7/16 in. in the throat for wheels having a maximum weight of 700 lbs.

In Paragraph 15. Marking. (The last sentence of this paragraph should read as follows). Wheels conforming to the requirements and furnished under this specification shall have plainly formed on the outside plate, M. C. B. 1909 for wheels of nominal weight of 625 and 725 lbs., and M. C. B. 1917 for wheels having a nominal weight of 700 and 850 lbs.

Sufficient time has not elapsed since the adoption of the new recommended practice cast-iron car wheels of 700 lbs. and 850 lbs. weight to draw any conclusions based upon actual service. The committee is not in position to recommend changing the shape of the plate or the weight of the 625 and 725 lbs. wheels.

Train Resistance and Tonnage Rating.

The report on Train Resistance and Tonnage Rating was presented to the Master Mechanics' Association by Messrs. O. C. Wright, chairman; H. C. Manchester, C. E. Chambers, J. H. Manning, Frank Zeleny, J. Chidley, J. T. Carroll, and Prof. E. C. Schmidt. A circular with eleven questions was sent out by the committee, and twenty-five answers were received. None of the roads replied to the first six questions. The B. & O., however, sent in a plotted curve, drawn from tests on that road on October, November and December, 1910 and January 1911. This curve represented the average of the cars used, running on 90 and 100 lbs. rails, on rock ballast. The average temperature was 75 degs. Fahr. The P. R. R. lines west gave a curve showing resistances with classes of cars, which

were run on 85-lbs. rails and cinder ballast.

	Gl.	Gla	Glb
Capacity, lb.	100,000	100,000	100,000
Light weight, lb.	39,200	39,050	38,700
Wheel base.	28 ft. 9 in.	27 ft. 9 in.	27 ft. 3 in.
Type of truck	Arch Bar	Arch Bar	Arch Bar
Size of journal	5½ in. by 10 in.	5½ in. by 10 in.	5½ in. by 10 in.

The New York Central lines gave information regarding increased tractive power due to superheat. The information is for two locomotives identical in every respect with the exception of the superheater. The data for these locomotives are shown in tabulation below:

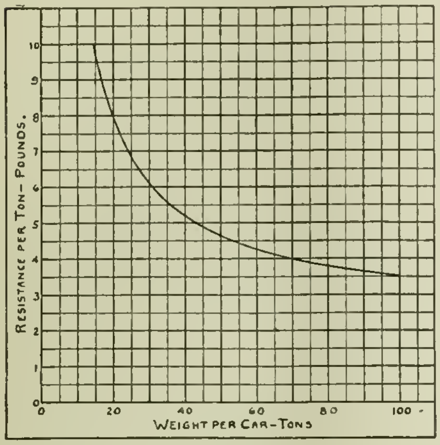


FIG. 1. B. & O.

Item	Saturated	Superheated
Class	G-6	G-6
Size of Cylinders.	3 in. by 32 in.	23 in. by 32 in.
Diamet. of Drivers	63 in.	63 in.
Steam Pressure ..	200 lb.	200 lb.
Grate Area......	56.5	56.5
Number of Large Tubes	None	34—5⅜ in.
Number of Small Tubes	444—2 in.	233—2 in.
Tube Heating Surface	3,474 sq. ft.	2,542 sq. ft.
Fire Box Heating Surface	185 sq. ft.	185 sq. ft.
Total Heating Surface	3,659 sq. ft.	2,727 sq. ft.
Superheater Heating Surface ...	None	580 sq. ft.

The information on Plate "C," our Fig. 3, in regard to the value of the superheater corroborates information included in committee's report in 1916.

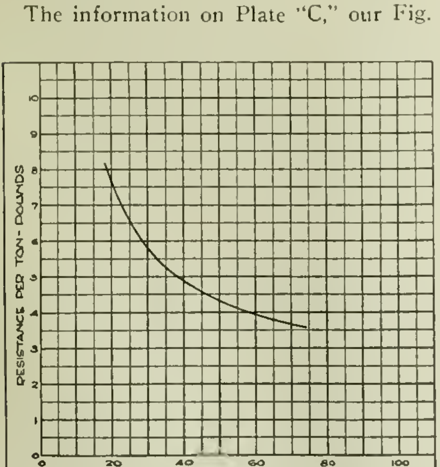


FIG. 2. P. R. R.

The supervision of the application of tonnage rating should be carried on from two standpoints. First, from the standpoint of the mechanical department, to see that the locomotives are so designed and maintained as to be able to deliver at all times, under the conditions to which they are subjected, their rated drawbar pull. It is necessary to know that the boiler is of sufficient capacity to supply the cylinders with steam at full boiler pressure and that it is possible to supply the firebox with the required amount of coal to evaporate the required amount of water. A mechanical means of delivering necessary coal to the firebox should be provided when it is necessary.

Second, from the standpoint of the transportation department. This department should be vitally interested in this subject, and the question of loading trains under different weather conditions should receive most careful supervision from this department.

The committee recommended that on every railroad the chief transportation officer provide a means of following up closely the train loading from day to day, with a view of determining the cause for hauling less than the rated tonnage and correcting the practice wherever possible.

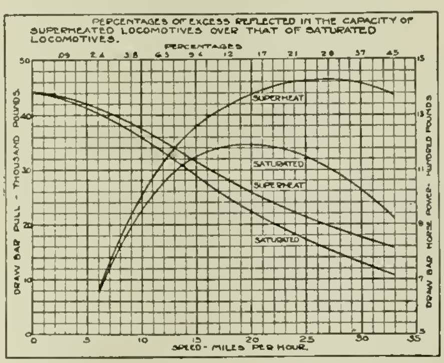


FIG. 3. N. Y. C.

The question in regard to taking into account the mechanical stoker, was asked by the committee in view of the fact that some of the roads have shown in their tabulated tonnage rating sheets higher tonnage for locomotives equipped with the stoker by from 5 to 13 per cent as compared with locomotives of the same type not equipped with stokers.

The committee cannot ignore the generally known fact that many locomotives when hand-fired by a good fireman, cannot develop the maximum power for which they were designed, and that similar locomotives, without mechanical stokers, are operated at their maximum possible rate of steam production and developing their maximum power. And it is our opinion that advantage should be taken of the opportunity of hauling whatever increase in tonnage is made possible by the ability to maintain full steam pressure by the use of a mechanical stoker. This is a matter which should be taken care of in the designing of the locomotive.

Couplers.

The standing committee on couplers, embracing R. L. Kleine, chairman; F. W. Brazier, F. H. Stark, J. W. Small, J. A. Pilcher and W. Alexander, reported that observations of actual couplings were made in the Norfolk & Western Railway yards on different occasions with a view of detecting any difficulty in coupling with the No. 10 lines at slow speeds. Employees in the yards were also interviewed on the question, but in no instance has any difficulty been reported in coupling with the No. 10 lines. The No. 5 or 10 contour are both acceptable. While slack in coupling has generally been considered undesirable, a certain amount of slack in any contour line is essential to provide for freedom in coupling as well as angling. It is not the initial slack in the contour line, but the ultimate slack developed by wear and distortion of parts with which the committee were concerned. The average slack per coupling in a train of 61 old cars was 1.66 ins. per coupling, while in a train of 26 new cars the average slack per coupling was only .64 in. per coupling.

A subsequent investigation showed that 10 couplings of No. 5 contour average 1.112 in. slack per coupling, and 14 couplings of No. 10 contour averaged 1.268 in per coupling. Assuming that these couplers were of the mean contour when applied, the results would indicate that both lines are developing slack, the development in the No. 5 lines being at the greater rate. A third investigation covered a number of complete trains of 90 ton cars on the Norfolk & Western Railway, at which time the railway had 750 cars of 90 tons capacity three years old, half of which were equipped with "A" couplers and half with "B" couplers. These cars were of the same series as those referred to in the second investigation. Also 1,000 cars of 90 tons capacity, nine months old, half of which were equipped with "C" and half with "D" couplers. The different couplers were divided about evenly between No. 5 and No. 10 contours. The average slack in No. 5 contours was 1.455 ins., and with No. 10 contours, 1.423 ins. In the case of "C" and "D" couplers, the average slack with No. 5 contour was 1.003 ins., and with No. 10 contour, 1.231 ins.

These figures verify the deductions made in the second investigation, that while the slack initially in the No. 5 contour is less than that in the No. 10 contour it increases more rapidly in service in the former. It also shows that the slack is about equal in both lines after three years' service and that this slack is less than in the old M. C. B. couplers with the M. C. B. 1904 line.

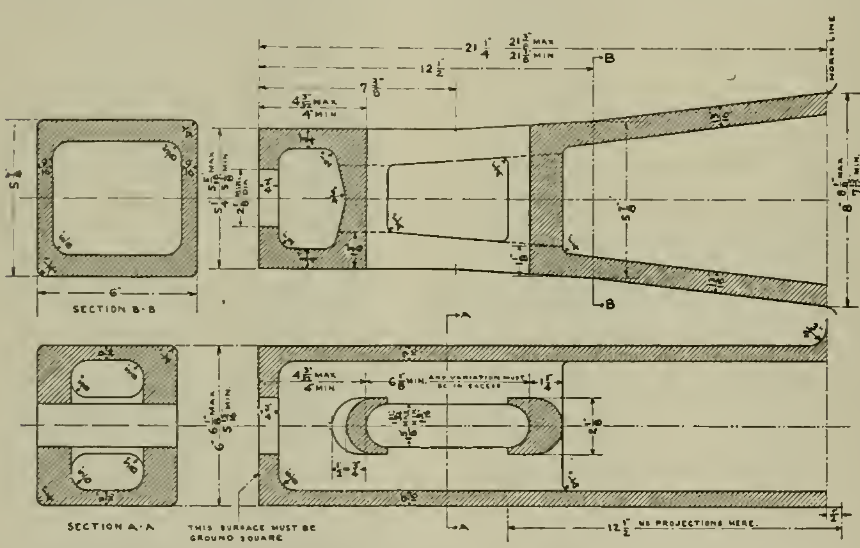
The No. 10 line on account of having the coupler face and front face of knuckle parallel to each other and perpendicular to the longitudinal center line of coupler

shank provides ideal conditions for pushing service in that it keeps the longitudinal center line of mating couplers in alignment. This was clearly demonstrated in tests conducted on a two per cent grade and nine degree curves on the Pennsylvania Railroad with locomotives and cabin cars equipped with No. 10 contour line couplers. By eliminating the inclined face on the head of the coupler the nose of the knuckle is relieved of strains in coupling and buffing; furthermore, the wedging action due to knuckle engaging both the face of the coupler and guard arm is also eliminated.

At a joint meeting of the coupler manufacturers and M. C. B. Coupler Committee, held at Altoona, March 29, 1918, the coupler manufacturers were unanimous that but one contour line should be adopted and that the same should be decided by the Coupler Committee. Your committee thereupon unanimously agreed to recommend for adoption the No. 10 contour line.

At this meeting Mr. R. E. Janney, of the American Steel Foundries, presented his views on the contour lines with the request that the same be embodied in the minutes of the meeting. Accordingly it was included.

Our illustration shows the design ot the 6-in. by 8-in. shank as agreed upon between the coupler manufacturers and M. C. B. Coupler Committee at the meeting held at Altoona, March 29, 1918. This design was also approved by the Committee on Car Construction and conforms with the design adopted by the United States Government for freight cars. This shank takes a 1½-in. by 6-in. key.



M.C.B. STANDARD "D" COUPLER; DETAILS OF DESIGN OF 6 X 6 INS. SHANK.

Design and Maintenance of Locomotive Boilers.

A committee consisting of C. E. Fuller, chairman; A. W. Gibbs, D. R. MacBain, M. K. Barnum, R. E. Smith, C. B. Young and J. Snowden Bell, reported on the above subject, and confined their investigations almost entirely to the use of autogenous welding as applied to locomotive boilers. The details were gathered from thirty-six railroads, and from the report it was evident that the construction and renewal of smoke boxes is handled expeditiously and economically by the use of autogenous welding. Oxy-acetylene and electric seemed to be about equally popular. The usual method is to tack the edges of the sheet together at intervals of about 8 ins. with strips about 2 ins. long, then complete the weld, thus providing for more uniform expansion of the sheet than if a through weld was made. The voltage at the panel is usually about 70 reduced at the arc to about 25. A 3/16 in. welding rod appears to give the best results. Practically all roads reported cutting off old or damaged smoke box plates by oxyacetylene. The reinforcement rings in smoke boxes are usually not disturbed, the weld being made ahead of the ring.

Flues are also being safe-ended by autogenous welding. The welding of back flue sheets is not greatly in favor, but its use in repairing cracks in the knuckle or flue sheets is general. Some weld on the water side only, and some in the fire side only. A 3/16 in. rod appears to give the best results in this class of work. The burning off the ends of projecting staybolts before riveting is much in favor. In welding cracks radiating from staybolts, it is customary to remove the staybolt and to bevel both hole and crack to 90 degs. and fill the hole and crack solid; the sheet is then drilled and tapped for a new staybolt.

Regarding new fireboxes the electric welding process is quite general. Door sleeves are renewed, part wrapper sheets and part back heads applied, and the application of patches reduced to a minimum by welding, the latter being about 60 per cent of the cost of riveted patches. In regard to the length of cracks welded, 8 ins. is generally considered as long a crack as it is desirable to weld for permanent repairs. The method in repairing cracked mud rings is to cut out a piece of the side sheet over the crack in the mud ring, bevel the mud ring from the top, then fill up the opening, after which the sheet is patched. If the mud ring is removed it is preferable to bevel the crack in the mud ring from both sides. A large saving is made by welding mud rings in place. The welding wire is usually ¼ in. in diameter.

Among other repairs cited are washout plug holes, reclaiming superheater units, building up worn places or stayed surfaces and welding up abandoned flue or plug holes. The use of a carbon electrode or a metal electrode is primarily dependent on the size and strength of weld desired.

The carbon electrode process should be used on work of considerable size. It is customary to heat around the weld, so that extensive contraction may be avoided. The current required for carbon welding is about 400 amperes. The metal electrode process, used in the various phases of boiler maintenance work, has the advantage of confining the heat more closely and is used for welds requiring strength and small work. The current required has a much lower value than that used, than that with the carbon electrode process.

It is better after starting a weld to complete it if possible before stopping, on account of the effect of the contraction of the sheet if work ceases. In some cases it is advisable to have two men working alternately. At the same time it is believed that the art is still in a formative and developmental state, and greater progress is expected in the near future. A warning should be pointed out against too radical application. Stayed surfaces and appurtenances, which are not subject to direct radial pressure, offer a safe and attractive field for future experiments, and any work for the time being should be limited to these sections of the boiler.

Revision of the Rules of Interchange.

The committee on rules recommended that the changes in prices be made effective as soon as possible.

The report is signed by J. J. Hennessey, chairman, T. W. Demarest, Jas. Coleman, F. W. Brazier, and T. H. Goodnow stated that with the approval of the Executive Committee the committee on rules of interchange was continued. Regarding the rendering of interpretations of such questions as have been asked by the members regarding the rules the committee has decided that until the status of the Master Car Builders' Association in relation to the Master Car Builders' Rules

of Interchange shall be established no change in these rules will be recommended except in the rules governing prices of material. During the year, arbitration cases No. 1061 to 1147 have been decided and copies have been sent to the members in accordance with our usual practice.

The committee dealt with rules 98, 101, 111, 120, also passenger car 21 and 22.

Specifications Tests for Materials.

This report is signed by C. D. Young, chairman, J. R. Onderdonk, J. J. Birch, I. S. Downing, Frank Zeleney, A. H. Fetters, H. B. MacFarland, G. S. Sprowle and H. G. Burnham.

The committee report covers the different subjects which were reviewed during the past year and recommends that changes be made in the several specifications, as shown under the respective exhibits.

Exhibit A.—Specifications for Steel Axles.

Exhibit B.—Specifications for Mild Steel Bars for Passenger and Freight Equipment Cars.

Exhibit C.—Specifications for Rivet Steel and Rivets for Passenger and Freight Equipment Cars.

Exhibit D.—Specifications for Heat-Treated Knuckle Pivot Pins for Passenger and Freight Equipment Cars.

Exhibit E.—Specifications for Air-Brake and Train Air-Signal Hose.

Exhibit F.—Specifications for Welded Pipe.

Exhibit G.—Specifications for Air-Brake Hose Gaskets.

Exhibit H.—Specification for Structural Steel Plate and Steel Sheets for Passenger Car Equipment.

Report on Brake Shoe and Brake Beams.

This report is signed by C. D. Young, chairman, Prof. Chas. H. Benjamin, T. L. Burton, C. B. Young, C. H. Bilty, G. H. Gilman and T. J. Burns.

Owing to the existing conditions arising from the national crisis the committee has only been able to meet once this year. It has agreed that, with the exception of one item, it would report progress for the year 1918.

The committee recommends that M. C. B. "Standard Brake Head, Shoe and Key-Standard Gauges for Brake Head and Shoe" be changed.

The following subjects upon which the committee reports progress are:

First.—The desirability of modifying the present standard brake beam gauge, with a view of simplifying the gauge and reducing its cost; the new gauge to provide for checking substantially the same dimensions and angles as the present gauge.

Second.—M. C. B. new standard contour for brake head. The question of a modification of this contour to meet foundry practices, as recommended by brake beam manufacturers, is being considered. The committee is awaiting its final decision for additional information, and to ascertain what, if any, action is taken by the Railway Administration in providing a new brake head for the cars being purchased this year.

Third.—The present Recommended Practice M. C. B. shows the recommended practice for No. 2 Brake Beam. The committee is considering, in connection with this beam, the location and design of two upper hanger openings, in order to provide a more satisfactory bearing area for the openings to meet certain requirements in foundry practice, as suggested.

Welding Truck Side Frames, Bolsters and Arch Bars.

The committee of the M. C. B. Association to whom this subject was assigned were: Messrs. W. O. Thompson, chairman, G. W. Rink, J. J. Hennessey, A. M. McGill, R. W. Schulze, Willard Kells, J. R. Gould, E. H. Sweeley and C. F. Giles.

One of the items brought out in this report was the selection of operations.

First.—Experience has shown that an ordinary helper, handy-man or laborer is not possessed of the ability to make proper welds, as they are not conversant with the changes which metals undergo while being welded. A competent mechanic should be selected and given the necessary instruction by an experienced welder before being assigned to this important work. When the desired proficiency has been acquired, the operator's ability should be certified to by the mechanical officer in charge or by an instructor qualified by experience in general railroad welding with the method involved.

Second.—Only in an emergency should an attempt be made to weld a side frame or bolster until it has been removed from the car, and whenever it is necessary to do so the recommendation should be made by a competent operator or instructor.

Third.—Great care should be exercised to prevent welding under load becoming a general practice for the reason that internal strain is liable to be set up through welding, which can be avoided by preheating. Therefore, it is considered good shop practice to preheat cast steel and pressed form bolsters and side frames and this should be done whenever possible.

Fourth.—In making the weld the fracture should be cut or burned out beveled or V-shape in order that a good surface will be obtained for the uniting of the metal, care and patience as well as skill being employed to prevent oxidization. To insure this, the work should be placed at an angle that would allow the flowing out or blowing out of all slag or impurities in the fused metal; the operators giving the torch a rotary movement, will assist in their removal and make a stronger weld than if this practice was not observed.

Report of Committee on Loading Rules.

The report of the committee on the above mentioned subject was signed by A. Kearney, chairman, A. B. Corinth, L. H. Turner, R. L. Kleine, E. J. Robertson, C. N. Swanson, H. C. May and H. H. Harvey.

The committee submitted the following recommendations covering additions and changes in the present Code of Loading Rules. The committee has received a number of recommendations and suggestions from the Regional Directors and others, relative to new rules to cover lading not taken care of in the present Code of Loading Rules and changes in the present rules. The suggestions in the main have reference to the conservation of the car supply by increasing the load carried per car and by prohibiting the use of hopper bottom cars for shipments of pig iron, billets and similar material, so that this type of cars may be available for ore and coal shipments.

On account of the apparent necessity that immediate action be taken, this committee has prepared several new rules and revised others, sending them to the executive committee for their approval, they being later issued as a supplement to the present Code of Loading Rules.

The rules which have been revised and issued as a supplement to the present Code of Loading Rules by the Executive Committee are for convenient use.

Specifications and Tests for Materials.

A committee consisting of C. D. Young, chairman; J. R. Onderdunk, A. H. Fetters, Frank Zeleny, H. E. Smith, H. B. MacFarland, Prof. L. S. Randolph and F. M. Waring reported on a variety of subjects which were viewed during the past year, including also reports of the previous year, and submitted their recommendations by selections from a mass of "exhibits" running all the way from the detailed dimensions and qualities of rivets to that of locomotive cylinder castings, cylinder bushings, cylinder heads, steam chests, valve bushings, packing rings, superheater castings, tank and underframe rivet steel, welded pipe, steel axles, staybolt iron, shafts and other forgings. The methods of inspecting and testing the same were given in detail, all showing how carefully the committee had investigated the subject, and compared the results with previous investigations. A number of variable admissions were distinctly specified, so that the report lacked nothing on completeness. Many minute changes in the previous tables were recommended, all being the result of extended experiments conducted under the most exacting conditions.

TRAIN BRAKE AND SIGNAL EQUIPMENT.

A report by Messrs. T. L. Burton, chairman, B. P. Flory, J. M. Henry, R. B. Rasbridge, W. J. Hartman, L. P. Streeter and G. H. Wood on Train Brakes and Signal Equipment was presented to the M. C. B. Association.

The committee submitted the following report:

J. E. O'Hearne, superintendent motive power, Chicago & Alton, having reported improper performance of brakes on passenger cars having a water raising system in conjunction with L triple valves and suggesting that the air supply for the water raising system on cars with this type of triple valve be taken from the air pipe leading from the triple valve to the supplementary reservoir, adjacent the former, the subject was considered in conjunction with practically all types of passenger brakes. The committee believes that, as a fundamental principle, when the water raising system is used on cars whose air brake equipment includes an air reservoir, which is supplementary to the auxiliary reservoir, the air supply for the water raising system should be taken from the reservoir in which the air pressure is not reduced during service brake applications. On this basis the air supply should be taken from the following points in the brake system with the types of brakes mentioned below:

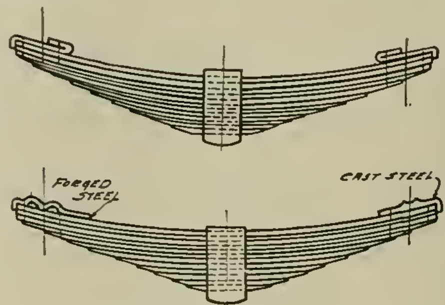
First, the charge should be proportional to the service rendered. Second, the inauguration of such a scheme would necessitate a difference between charge and credit which would be in excess of the present charge for cleaning and oiling only, and less than the present permissible charge for repairs, thereby tempting a road handling foreign cars to neglect entirely the question of repairs, and to confine attention to the more profitable job of cleaning and oiling for which the authorized charge would be excessive. Third, granting that the proposed method, if adopted, would not encourage "bad practice" on the part of repair men, considerably more time and labor would be required than is now available in arriving at a satisfactory credit and charge price.

It is earnestly and unanimously recommended that the Master Car Builders' Association quickly supplement interchange rule No. 60, at least for the duration of the war, so that foreign car brakes bearing cleaning stencils nine months' old or more may, when on repair or other tracks where the work can be done, be cleaned and repaired and the proper charge made against the owning road.

The committee carefully considered the resolution and recommends its adoption by the M. C. B. Association, if concurred in by the proper committee on rules. In fact the practice on many roads is to clean, oil and test brakes on home cars when the stencil dates are approximately nine months old.

Semi-Elliptic Springs—Shop Manufacture and Repair—Design and Appliance.

The committee having the manufacture, repair, design and appliance of semi-elliptic springs, was composed of Messrs. M. F. Cox, chairman; Elliot Sumner, A.



FIGS. 1 AND 2.

G. Trumble, E. W. Pratt, T. A. Foque, C. A. Gill and G. W. Rink. The report was made to the Master Mechanics' Association, practically as follows: In the operation of manufacture eleven events were enumerated. The more camber a spring has, the stiffer it is apt to be. The amount of deflection a spring will withstand, under a given load, without permanently changing its form determines its elasticity.

Many manufacturers are now making locomotive springs with main leaves and end clips as shown by our illustrations, Figs. 1 and 2. By this method two expensive operations are eliminated. Clips made of scrap spring steel or boiler steel are best. Malleable iron clips are suitable only for light equipment. The practice of welding on a slab of iron or mild steel and forming it at the same time under the hammer, with dies, is by no means obsolete.

In small shops band-making is usually done by hand and the stock is equal to that of the crown band. The fuller is used after the ends are drawn down, bent and welded. When the stock is standard for size of the band the bending may be

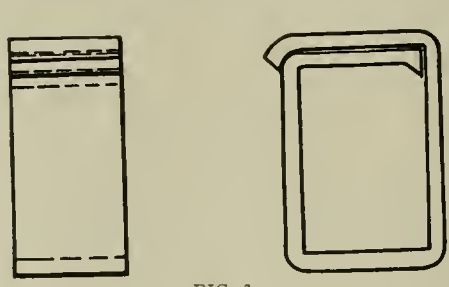


FIG. 3.

done on an air press or on a Bradley strap hammer, as shown in Fig. 3. Our other illustration, Fig. 4, shows the most approved method of making bands on a machine. The setting or cambering precedes the tempering. After slowly heating to a good red color they should be drawn down with short, rapid strokes of the hammer.

To properly temper springs the furnace must be properly constructed and an oil tank of 200 gals. provided. The oil must be surrounded by sufficient water to keep it cool. Fish oil has been generally used and it has been found satisfactory. A tempered plate after becoming cold should not be struck with a hammer, as this often leads to fracture in service. The use of hydraulic or pneumatic power is essential for assembling, clamping, application of band, etc.

A drawing of a common form of coke furnace accompanied the report. It contains a fire chamber, with grate and ash pit. It also has a bridge wall, top and bottom flame working chamber, damper and chimney. The whole encased in sectional cast iron plates bolted together. The interior construction is so arranged that the flame and gases are baffled back and forth through the combustion chamber. The temperature is regulated by the damper. The cold template over which

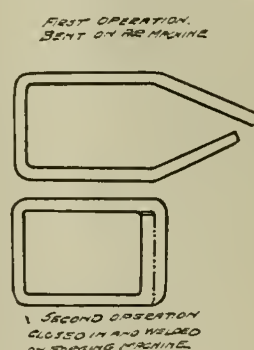


FIG. 4.

the hot one is rolled should be in position between the rolls of the machine. The operation is smooth and noiseless, and the plates do not require hammer blows.

Reclaiming spring plates is not altogether a satisfactory operation. The committee believe it is good practice to do all spring work in one shop, centrally placed, where men may be trained to be expert spring workers. In such a shop there should be a supply of all the necessary tools and such scientific equipment as will ensure a high grade of workmanship. The greatly increased size and weight of modern locomotives makes the subject of springs one of considerable importance. There is still room for improvement, both as to methods of repairing and manufacturing springs. The greatly increased size and weight of modern locomotives makes this subject one of considerable importance. There is still room for improvement, both as to methods of repairing and manufacturing springs.

The operation of re-applying an old spring band is the same as that required for a new one, as is also the retesting of the spring. Spring inspection should include loose bands, broken plates, free height below standard and total thickness of plates at edge of band.

The Report of the Tank Car Committee.

The M. C. B. Committee on Tank Cars consisting of Messrs. A. W. Gibbs, chairman, Thomas Beaghen, Jr., C. E. Chambers, Wm. Schlafge, S. Lynn, John Purcell and O. J. Parks, reported that for the year 1918 the Tank Car Committee does not recommend that the existing specifications be disturbed.

Owing to the conditions brought about by the war, it has been necessary to suspend some of the requirements, as, for instance, that of the use of flange quality steel in the construction of Class III tanks, and that of hydraulic retests of all classes of tanks, the former until July 1, 1919, and the latter until January 1, 1920.

Train Lighting and Heating

Messrs. J. R. Sloan, chairman; C. H. Quinn, D. J. Cartwright, E. W. Jansen, E. Wanamaker, Alex. McGary, and L. G. Billau signed this report: The committee, as recommended in last year's report, took up the question of standardization of ball bearings for axle generators. The 412 bearing in ball annular size had been made recommended practice for truck hung axle generators and had been generally adopted by the generator manufacturers previous to the advent of the body hung generator. When the committee took the matter up it found that body hung axle generators were on the market, using the following sizes of ball bearings, viz., 304, 307, 308, 312, 407, 408, 409, 410, 411 and 412, a total of ten different sizes.

The committee obtained from the axle generator manufacturers all data relative to the various types of axle generators they were building, or contemplated building, necessary to determine the proper size of bearing to use. This information was transmitted to the ball bearing manufacturers, who formed a committee and made recommendation as to the size of bearing that should be used in each case.

A joint meeting of the representatives of the ball bearing manufacturers, axle generator manufacturers, and this committee was then called.

The Revision of Standards and Recommended Practice

The committee reporting to the M. M. Association was composed of Messrs. W. E. Dunham, chairman; M. H. Haig, A. G. Trumbull, C. D. Young, G. S. Goodwin, R. L. Ettenger, and B. B. Milner.

After consideration of the present Standards and Recommended Practices of the Association, together with the replies received to the circular of inquiry sent to members, the committee submits the following report, dealing with a number of suggestions proposed by members and others: The suggestions covered axles, wheels, boxes, wedges, bearings, steel tires, steel-tired wheels, solid wheels, chain, safety appliances, etc., etc.

Feed-Water Heaters.

Mr. J. Snowden Bell, of New York, presented an individual paper on the Development of Locomotive Feed Water Heaters. Mr. Bell said among other things:

The economic value of an appliance by which any substantial portion of the heat units contained in the waste gases of combustion and the exhaust steam of a locomotive can be made available in heating boiler feed water is too obvious a proposition to require discussion, and it was recognized by engineers at a very early day. While experiments have been made from time to time with numerous appliances of this character and have ordinarily failed to prove sufficiently satisfactory in practice to cause them to be continued in regular service, the undeniable correctness of the general principle upon which they are based warrants, if not positively demands, its renewed consideration, particularly in view of the rigid economies in every department which present conditions have rendered indispensable, not merely to the profitable operation, but even to the very existence of the railroads of the United States.

After a general review of a number of feed-water heaters, Mr. A. L. Holley, in his comprehensive book, "American and European Railway Practice in the Economical Generation of Steam," 1861, makes the following statement:

"It is impossible to state the exact economical results of feed-heating—either the saving of fuel or the cost of repairs; because no experiments which fairly estimate all the conditions have been made. It is quite sufficient, for present purposes, however, to know that there is a saving worth making, and it is very obvious that the cost of maintaining such heaters as Clark's and Eaton's cannot materially detract from the economy. It would, therefore, be unreasonable to neglect this improvement any longer, on lines, at least, where fuel is expensive." (p. 130.)

Mr. Holley's statement is as correct and noteworthy today as when written 56 years ago, and its importance is accentuated by the fact that appliances of improved construction have been produced since he wrote it. Feed-water heaters are of two types: surface heaters and injection heaters. The former type, in which the transfer of heat from gases or steam to the feed water is effected through walls of comparatively thin metal, is that which has been the more frequently experimented with, and, for several reasons, would seem to be the more practical and desirable of the two types.

In a report on a system of feed-water heating used in France, the following conditions were laid down by a committee of French engineers, in 1896, as being those which should be followed, as nearly as possible in a locomotive feed-water heater: "First, simplicity, and facility for examination, cleaning and overhauling; second, that the heater should take up little room and be of a minimum weight; third, the heater should give a continuous and certain supply of hot water; fourth, that the feed heater should be heated by steam that would otherwise be lost; fifth, that the steam used for the heater should vary with the quantity of feed required."

The paper of Trevithick & Cowan (*Proceedings, Institution of Mechanical Engineers*, Eng.: March-April, 1913, pp. 353-356) clearly indicates that to effect the increase of the temperature of feed water to such a degree as will result in a substantial economy sufficient to warrant the application of a feed-water heater, a pump must be adopted as the feeding member instead of an injector, and this has been done in the systems before noted as having met with approval in European practice. After stating that two feed-water heating agents are available, i. e., the exhaust steam discharged from the cylinders and the waste gases passing out of the stack, and that the process may result in reaching temperatures at which even the so-called hot-water injectors will not work, they proceed with what they term "a reconsideration of the feeding system generally," the following excerpt from which is believed to be of sufficient interest to be here presented:

"The ordinary injector will not pick up water above about 120 degs. to 125 degs. F., and the feed cannot, therefore, be effectively heated before it reaches the injector, while the admixture in that apparatus of live steam with the feed so raises the temperature of the latter that full advantage cannot be taken of subsequent heating by either of the agents available. An injector may feed into a boiler at 180 lbs. per sq. in. pressure, about 11.2 lbs. of water for every 1 lb. of steam used. If the supply be at 65 degs. Fahr. the delivery will be about 160.5 degs. Fahr. This increase is not an economic gain. Delivery falls off as the boiler pressure rises, and the temperature of delivery is higher at the higher pressures. Subsequent feed-heating is of less advantage now than it would have been when pressures were lower."

Concluding Business

Dues of the association will remain the same as last year.

Owing to the resignation of William Schlafge, president of the association, an election of officers was necessary. The following were elected: F. H. Clark, general superintendent motive power, B. & O., president; W. J. Tollerton, general mechanical superintendent, C. R. I. & P., first vice-president; C. F. Giles, superintendent machinery, L. & N., second vice-president; C. H. Hogan, assistant superintendent motive power, N. Y. C., third vice-president; and H. C. Manchester, S. M. P. and E. of the D., L. & W., member of the executive committee.

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Conservation of Man-Power.

This phrase, "conservation of man-power," primarily means the saving of life. This applies not only to the battle-field, but to the industrial world as well, and it means in its fullest sense the protection of men so that they shall not become invalids, or maimed or injured in any way. It is keeping man-power safe from disease, accident and death. We have many and good factory laws intended to prevent injury and death. We have a sanitary code designed to preserve health, but there is another sense in which the phrase embraces something else of very great importance.

If an employer puts men to work at things which need not be done, he is not conserving man-power in the highest sense. If he uses two men where one would do, he is wasting man-power, or if he puts a man to do what an automatic machine could do, he is unnecessarily using up man-power. He is not economical in essentials if he does any of these things. If, however, he uses man-power wisely, he is not interfering with any of the economic laws of the world, because the men released from labor by conserving man-power are not wholly represented by a money saving, nor are these men turned out of employment to walk the streets, he is only releasing men for good, useful work elsewhere. That is the true essence of conserving man-power.

A phase of such conservation is some arrangement whereby a man shall last all day and every day and be able, all the time, to apply himself to his task. To do this fatigue and monotony must be eliminated as far as possible. The management of a machine which takes the drudgery of work away from a man, and leaves him free for the careful manipulation of the machine, tends to reduce fatigue and makes him a more efficient worker.

As an example in daily life at the present time, one may cite the employment of the men who run our locomotives. The call to the colors is imperative. It has been forced upon us. It has depleted the ranks of the very flower of our industrial army. It was not of our own choosing yet it is here with all its sinister consequences. The result of all this is that the men who would normally be retired are forced to remain at work. They are not exactly old men nor are they young, yet they can do good work yet. This may not be an unmixed evil, but rather a good thing, for the pendulum had well-nigh swung too far toward the "young man craze," which not so long ago swept over the land.

The older men, who have perhaps passed out of the ranks of the fast passenger and heavy freight runners, are available for switching service. They are not only available, but desirable for this kind of activity, because they know the work and are familiar with railway customs and procedure. They know the style of traffic handled by their own road and they know just what is wanted and how to do it. All this is summed up in the word "experience." These men are experienced, they are not raw recruits. The minds of these men are alert and keen, they can think and act. The one thing some of them may lack is the buoyant spring of youth, and its tireless activity.

The problem is to lessen the weight of the handicap, and give them power to turn their valuable experience to good account. In the running of a switching engine, a great deal of constant reversing of the engine is necessary and the stopping and starting is incessant. The use of the air brake is most easily accomplished and the opening and closing of the throttle valve is not what would be called laborious. Reversing the valve gear is the tiresome item in switch engine running. If any one of the power reverse gears now on the market be substituted for the heavy body, arm, and leg movement of the man, and the whole operation reduced to an equality with air brake manipulation, the men we have described are put on a parity with younger and stronger men, and the work does not suffer, but is more quickly done and better done by experienced men than by novices. Here we have the tending of a machine which takes to itself the drudgery of work and leaves the man free to apply his best judgment. This, according to our definition, is one form of the conservation of man-power, with work adequately, easily and fully done.

The same is true in the machine shop. Riveting machines, air hammers, hand-boring machines, and other drudgery-destroying appliances all attest to the soundness of the principle, and their regular employment in the shop supplies proof, if that were needed, of the practical efficacy and money-saving adjunct which the proper conservation of man-power always carries with it. It is not a profane use of the words of the Bible, when we apply them to the whole science of railway operation, to say, "Ye shall know the truth, and the truth shall make you free."

Burning Low Grade Fuel

In the account which we give in another column of this issue, Mr. Frank McManamy and Mr. Thomas Britt, speaking at the tenth annual convention of the International Railway Fuel Association, brought out the fact that large quantities of so-called fuel were composed of material which would not burn. Material which is not coal cannot be used, and there is no use experimenting with it. Fuel which is fuel, but of a poor quality, is often thrown away or produces so much ash that it is not worth the haulage, though it does produce some heat.

This poor fuel is capable of economical use as fuel if burned in a suitable way, and this way is to burn it as pulverized fuel. As an example, Rhode Island anthracite is a poor grade of coal, and is burdened with considerable quantities of graphite, slate and other non-combustible matter. With the means and methods now developed Rhode Island anthracite can be mined on a commercial basis. This will release very large amounts of fuel oil, Pennsylvania anthracite and bituminous coal now being transported by rail and water into the New England district, for other pressing needs. Rhode Island anthracite, heretofore unusable, has at last been made to burn as freely as gas or oil. The Locomotive Pulverized Fuel Co.'s System of burning such fuel in suspension has accomplished this. Results of recent tests seem to justify one in saying that New England can now draw on its own fuel resources.

With up-to-date equipment, the mining operations already established could be made to yield about 800 tons daily. On this basis Rhode Island anthracite, mined for fuel purposes, could be supplied to the New England district at a cost substantially below that of the best West Virginia coal for equivalent heat values. The output capacity could be further increased by new openings that would prove of great value in connection with the existing fuel situation.

There are about four hundred plants or mills in the Providence, Fall River, New Bedford and Taunton districts. Last year they used between one and one-quarter million and one and one-half million tons of coal. The advantages which would be derived from the development and utilization of regional fuel are very great. Much water and rail transportation now required to bring fuel oil and coal into these districts could be utilized to handle raw and finished materials.

The coal tested was some of the by-product from the Cranston mine of the Graphite Mines Corporation, south of Providence, R. I., and which is being mined for graphite. This coal was taken from near the surface and is below the average. Four openings now worked for graphite range from 125 ft. to 200 ft. in length, with an average depth of about 160 ft. and an average width of about 120 ft. The anthracite tested, before preparation, had been lying on the ground over six months and exposed to weather conditions, and it contained about 18 per cent of moisture.

The Rhode Island anthracite pulverizes with less difficulty than the Pennsylvania anthracite, apparently due to the lubricating factor of its graphitic nature.

The first test of this coal was made in connection with a 465 H. P. nominal rating Stirling type of stationary boiler, which was being regularly operated with the Pennsylvania pulverized anthracite. About six tons of pulverized Rhode Island anthracite was substituted for the pulverized Pennsylvania anthracite during the regular operation without any change in the feeding, nor burning equipment, nor altering the furnace in any way, nor any operating adjustments were changed. No difficulty was experienced, and the combustion was excellent. The final test was made under the same boiler for the purpose of determining the relative combustion and boiler efficiency. The Rhode Island anthracite burned in practically the same manner as the Pennsylvania anthracite, but with a greater accumulation of ash in the slag-pit due to the higher ash content in the coal.

Securing Positive Results.

Some time ago what luckily did not result in a railway accident, occurred on one of our railways. An accident did not happen, but it might have happened. An engineman in apparently good health, was suddenly overtaken with what is generally called heart-failure. His state was not noticed for some time by the fireman, busy at his work, and the train sped on at a good speed. His failure to whistle for a certain crossing caused the fireman to look at him, and ascertaining his condition, the fireman brought the train safely to a stop at the terminal. There was no accident. There was only the menace of one, and that was removed by the fireman.

Signals set at caution or at danger would be of no use where clear comprehending vision had been suddenly superseded by the dull stare of sightless eyes, and where for intelligent action, there remained only the nerveless hand of death. The passengers escaped with their lives, but the grave danger had been there. It was a danger of which they were ignorant, and therefore were powerless to resist. The busy fireman for some time ignorant of the very shadow of disaster, was their only hope of safety. What most men call good luck was vouchsafed to them. They lived and were thankful.

In this, as in other cases to which we have made allusion, it is not necessary for a locomotive runner to die suddenly at his post. A mental aberration for the time may cause him to be practically unresponsive to a signal's position, or to the significance of its colored lights. The man may appear normal, even under the scrutiny of his fireman and yet be making a grave mental error. The "dead-man's handle" on electric trains, where there is no fireman, has been designed to obviate his solitary condition, but the safety controller does more than take the place of a watchful mate. It prevents an incapacitated man from letting his train run away.

A speed and stop-control device has even a stronger reason for its being, as it enforces obedience to its warning and thus secures a positive result. It does this irrespective of whether the effort to pass it unheeded, is caused by death, or by faint or by some form of temporary mental aberration, which we all often loosely speak of as carelessness. The caution device which enforces a reduction of speed to safe limits, or a stop mechanism which actually halts a train definitely and positively, are among the railroad appliances which are urgently needed.

These are the days, above all others which have gone before, where the conservation of man-power has become a national requirement. Pershing, Haig and Pétain are generals in the field and the "work" of war is to destroy men, and each side to ruin the other. It is a stern and pitiless business, and although no sane man doubts the ultimate and full success of the Allies, of which we are in heart, one, it is, and will be, a hard fight. In the work of destruction, these generals are expected, as far as possible, to save their men. They have not the autocratic idea that man-power may be wasted. If it is not admissable in our war, where destruction is the ruling motive for attack or defense, why should the unnecessary loss of life be even tolerated in the industrial army? An accident with the loss of precious human life caused for want of automatic control devices when such appliances are to be had, is a grave matter. RAILWAY AND LOCOMOTIVE ENGINEERING has no pecuniary interest in any such device nor has it carried a single line of advertising relating to the subject, and what we have said is in the interest of no one concern, but it regards this matter of so great importance to railroads that it offers no apology for espousing the principle involved.

Prof. G. T. W. Patrick, of the State University of Iowa, says, in a recently published article: "The surface of the earth happened to be underlaid with iron, coal and petroleum, and man happened to discover them and devise ways of using them, and they have suddenly made for him a totally new environment. Not only have they changed his environment but they have produced disharmonies in his nature by compelling him to live under new conditions, for which evolution had not adapted him."

Will any one say that engine running and management amid caution, stop and switch signals; at night with other lights, forming a veritable galaxy of suns and moons and stars; is a work traceable to evolution? Is it not rather a highly complex, artificial employment in which every aid should be given to obviate the effects of death or the temporary and often involuntary return to race characteristics and to habits formed in the earliest dawn of intelligence and the gradual growth of experience in essential pursuits such as war or the chase or the tilling of the soil. The modern artificial life of man requires automatic protection in many ways, and wherever possible. The control and stop device is one of these.

European and American Practice.

At present the scarcity of skilled labor and its high cost emphasizes the fact which long ago led to the adoption on the American continent of a system of maintenance and design of rolling stock differing from the European system. The development of this idea has caused the American locomotive to vary more and more widely from its relatives across the water, until at present an American locomotive in Europe is a stranger in a strange land, probably doomed to failure, because of the impossibility of co-ordinating the machine with the European shop and personnel. The "American idea" in locomotive maintenance briefly stated is as follows:

The locomotive must be so designed that it shall be capable of operating at approximately maximum capacity for a period (ranging from nine months to two years) with only minor repairs, such as may be handled in outlying round houses with only the most meagre facilities and practically without detention from service. This period is familiarly referred to as "between shops," and after its completion the locomotive goes to the

"back shop" and is practically rebuilt, coming out as good as new, or even better than new, as the present tendency is to take advantage of recently developed appliances making for economy and fuel saving, increase in power or reduction of maintenance.

The European idea on the other hand may be called the "stitch in time" plan. At the end of each run the facilities of a well appointed shop, with high class and at the same time comparatively cheap labor, is available. For this reason every detail possible is made adjustable, and the machine, beloved of the "driver," is given more than mere "running repairs" after each trip. Every slight thump is removed by the proper adjustment and valve gear is squared or changed as dictated by a skilled driver. These locomotives never wear out and are seldom rebuilt. The result is that they are continued in service long after recent developments in the art have rendered them obsolete, and according to any method of bookkeeping, a losing investment.

Without an abundance of skilled help, at a low rate of compensation, such a plan would be impossible and could not be long continued with the low freight and mileage rates, long reaches of non-producing country, "regulation" by various states, etc., with which we have to contend. The difference in the two systems can best be elucidated by a comparison of the mechanical design of the various important parts of the American and European locomotives. It is briefly as follows:

Taking boiler tubes as the first example, we have American practice typified by iron welded into steel tube sheets with low first cost, practically no maintenance between shoppings. By the use of automatic fire doors and brick arches cold air is prevented from entering tubes, and their life prolonged; and European practice typified by tubes rolled into copper tube sheets with high first cost. The tubes require frequent re-rolling. The copper tube sheets and constant reworking of flues are necessitated by the fact that in firing, cold air is admitted directly in the flues.

In the matter of valve gear American practice has all parts forged the proper length and no adjustment is necessary when engine is properly built. Bearings are simple removable bushings. European practice seeks to have all parts made adjustable, to permit of fine and frequent readjustment by skilled mechanics. Bearings made with "take-up" arrangement.

When it comes to driving boxes American practice goes in for liberal bearing surfaces, no refitting between shoppings. Brasses: removable in many cases without dropping wheels. European practice tends to small bearing surfaces, frequent refitting. Brasses: pressed in, requiring the dropping of the wheels for removal.

American practice uses hard grease for driving box lubrication and no serious attention is paid to it, for from four to twelve months. European practice, on the other hand, uses oil, requiring inspection each trip, and frequent repacking of the boxes.

Driving box wedges in America are automatically self-adjusting in the latest practice, while in Europe they require frequent careful setting-up by skilled mechanics.

Main and side rods in America have solid ends with removable bushings. Very little attention is required if the wedges are properly adjusted, while in Europe they are made with a strap or solid keyed ends. All slack taken up at frequent intervals.

American practice regarding main and side rod pin lubrication leads to the use of grease, and the cups are screwed down once or twice each trip. European practice favors oil, and the cups are filled by driver at every opportunity.

The American idea makes engine and tender trucks quite massive, but light monolithic construction of steel castings are used. Few bolts and nuts or small parts are there to become loose. The European idea is for the built-up type, with a multitude of small parts secured by hundreds of bolts.

The spring rigging in America is of the non-adjustable type so designed that after permanent initial "set" is taken the engine is level and all parts in proper relation. In Europe each hanger is adjustable, and the engines are frequently levelled up by adjustment of hangers.

Lubricators in America are hydrostatic, requiring absolutely no maintenance. In Europe mechanical force feed is used. Connections to moving parts often give considerable trouble, and require careful attention and inspection to insure proper functioning.

The grates in the U. S. are power operated to reduce time of fire cleaning and therefore detention at terminals, as well as to insure economical combustion of poor coal. In Europe grates are generally hand operated.

A great many more cases of radical difference in practice might be mentioned, but what we have given will serve to illustrate the tendency of divergence and its cause. All this is of interest to us in the present crisis in showing the extreme pressure which has been brought upon the American railroad even in normal times, due to scarcity of and high cost entailed by skilled labor. How much more important is it now, in this period of maximum demand, coupled with increasing shortage of "man power" in this country to further the development of the "American idea" and to take advantage of all the "Yankee kinks" which time and experience have developed and which will pay 100 per cent or more on the investment.

These differences of practice exist and may be the result of the different styles of rolling stock that have grown up in each country to meet particular needs; or they may be the results of radically different viewpoints adopted by each, but in any case they seem to suit the people using what belongs to each land.

Theory and Practice

The old question of theory vs. practice, which was at first a protest by the old school of self-made men, against the advent of the college man in railway work, has largely given way to the advancement of science. The present day railroad man is better equipped than his predecessor, and yet mistakes have been made and are even yet being made as to the teachings and aims of what is called theory, but these are mistakes of judgment and interpretation, and are not the evidence of any radical antagonism between theory and practice, or in the correct methods of understanding them.

When a stream of water is allowed to run from a faucet the liquid, if the pressure be regulated carefully, will leave the orifice in a solid stream and will continue to maintain that form, unruffled by the air, for a considerable distance. As the water falls away from the faucet it quickens its pace under the influence of the attraction of gravity and the section of the stream becomes smaller and smaller. In fact, the sides of the unbroken column of water assume the beautiful form represented by a pair of parabolic curves. As the water moves faster and faster in its fall and diminishes the section of the column, we would naturally expect that if the distance traversed were great enough we should have a stream of exceedingly rapidly moving water, perhaps no thicker than a steel knitting needle, and ultimately a stream of practically no measurable thickness, moving infinitely fast.

As a matter of fact this never happens, because long before that state is reached, the falling water becomes subject to physical laws and it breaks into drops and so changes the whole phenomenon completely. The extremely thin stream moving at an exceedingly high velocity is a conception of the mind, not a reality. It is a perfectly legitimate conception, yet it ignores the physical changes which interpose themselves at some point in the downflow of water. This is theory pure and simple, and it no more upsets the practical view of things than when the tractive effort of a locomotive is calculated and transformed into drawbar pull with the friction of the machine left out, as it generally is. The point to be re-

membered is that it is incumbent on good judgment and knowledge to allow for physical changes at the right place, and at their full value, in dealing with a practical problem and not to throw over the theory altogether as useless and misleading. Engineering is sanctified common sense, and not a formula or a species of incantation which changes wrong thought and makes it right.

An ordinary gas, according to Boyle's law, shrinks in bulk 1/273 of its volume for every loss of heat corresponding to one degree of temperature on the Centigrade thermometer. It is manifest that, theoretically, such a gas would have no volume at all at minus 273 degs. C. This figure, which is not obtainable in this form, is called the absolute zero of temperatures. Most gases turn to liquids long before they attain this extreme degree of refrigeration, and this alteration from gas to liquid is a physical change which interposes itself and modifies the purely theoretical consideration, while not upsetting the reasoning based clearly and openly on the unhampered process of cooling. The absolute zero of temperatures is useful in many ways. The drawbar pull of an engine, ignoring friction, is a working basis of comparison between locomotives, which groundwork we cannot afford to entirely disregard simply because a fairly constant factor has been temporarily withdrawn from consideration. That is the internal friction of the machine.

All our efforts at knowledge of the world around us and of the physical forces which there hold sway are in reality more or less close approximations to absolute truth, and nothing can be said to be wholely, completely and inflexibly theoretical, and nothing dominantly and exclusively practical. The happy mean in this, as in other things, is our working basis and our salvation. There is no real antagonism between the two. Lack of understanding, appreciation, and the proper appraisal of facts is one of the great obstacles to our seeing in all these things, the fudnamental unity of nature, though often presented to us under many seeming disguises and aliases.

International Railway Fuel Association.

The annual convention of the International Railway Fuel Association, a condensed report of which appears in another part of our columns, is of more than usual interest on account of the large number of eminent men who contributed to the general mass of information on the subject of fuel conservation, which formed the main topic of discussion of the entire convention. Many of the statements were sufficiently startling to awaken a keen interest in the subject, and while the engineering press generally has been calling attention to the matter with a degree of earnestness, worthy of all praise, the meeting of the association cannot fail to focus more particular attention on the urgent need that there is for a united effort towards the saving of fuel by every means that may be suggested to human ingenuity. That there has been much waste is now apparent to every one, and that its importance at this time cannot be overestimated when we may be said to be engaged in a great national tragedy to the end that out of this appalling trial we may come to triumph. It should not need idle repetitions to induce a nation-wide movement on the conservation of one of the most vital necessities of our national defense, involving as it does the very existence of civilization, as we have been accustomed to look upon it.

That the people at large will rise to the occasion we have no doubt. That the railroad men have already risen to it we know, and that they will continue to do their part is just as assured as that history repeats itself. To this must be superadded the assurance that in the science of engineering we are not standing still, but out of the threat of shortage of material to meet the emergency will come the vitalizing and creative spirit that has met other emergencies. The American people have put their hands to the plough, and they will not look back again until the garnered sheaves of victory is theirs.

Address of M. M. Association Pesident.

Mr. William Schlafge, general mechanical superintendent of the Erie, had been made president of the American Railway Master Mechanics' Association; therefore, it devolved upon him to deliver the 1918 address to the members. In his absence he forwarded a paper which contained much that cannot be gainsaid, and as a plea for Government control it is all right. One or two points, however, seem open to debate. Mr. Schlafge weakens his otherwise good argument by pointing to what he considers a fault in the previous work of the Master Mechanics' Association. He asks: "Has this association so conducted its affairs, has it so impressed itself upon the thought of the railway world, has it achieved leadership?" One may answer yes and no. Yes, because there is no similar society. No, because it cannot enforce its rules. The M. C. B. by reason of car interchange can enforce its decrees, and it does not have to seek Government aid. The M. M. Association has no such power in itself, because locomotives are not interchanged. To do anything authoritative the Government is required to step in and complete the power of the organization which must be imperfect without such aid. It can do this itself or it can authorize the American Railway Association to do it. This, it seems to us, is almost self-evident. The devising of a standard locomotive was not done, as it did not appear in pre-war days to be called for.

As to Government intervention in any republic, it is necessarily slow, not arbitrary, carefully thought out, and applied in a kindly spirit. There is a complete absence of the sudden, tyranous, and autocratic application of force. The war measure by which the railways passed to Government control in the United States had in it all the best features; where supreme power was used to win the war, and not to throttle home enterprise or crush those citizens who for the moment were taken unawares. That may truly be the natural tendency or even the inevitable trend of events, in the introduction of supreme power in close association with private life, in a country constituted with the customs, ideals, and safeguards as those of the United States, rather than the accomplishment of any more or less narrow association design.

Free speech has not been forbidden and it is open to any railroad supply man to state his case definitely. The government is not disposed to be arbitrary. Only those in a rut have felt the strain of new conditions, we may well believe responsible government officers.

The association's president, however, is most highly to be commended for his words of encouragement in his exhortation of loyalty. These minor matters, to which we have referred, such as seeing fault in the behavior of the M. M. society, in whose minds in the last fifty years, war was the last thought to find lodgment—these are but the motes in the sunshine, when now an unheard of and unexpected emergency is upon us.

It would be degrading to the ability of the United States to say that in this broad land we were unable serenely to handle a new condition, and one fraught with such momentous issues to us. We have frequently heard the expression, "Have faith in the institutions of your country." Here is a concrete case. Reflect how the assumption of supreme power arose and how it is applied in a democratic country, and as a "member in good standing" of a modern republic, honestly, loyally, steadily and without panic, help to carry on the work as it should be done. Help the Government to win the war

When it comes to the consideration of the future, we may say that railroad supervision, in addition to mere rate making, has come to stay, and such new supervision, performed with authority, and not in the form of recommendations, will be found to be highly beneficial to all concerned The question of Government ownership after the war is an entirely different matter. No opinion of any value can now be offered. Conditions then will have changed—"Tempora mutantur nos et mutamur in illis."

Air Brake Department

Actual Value of Improved Brake Equipments for Electric Service.

By WALTER V. TURNER, Manager of Engineering, Westinghouse Air Brake Co.

The basic time and distance for braking are, for the 1906 PM equipment, 650 foot emergency stop in 21 seconds, service stop in 1,470 feet and 40 seconds time, both from 40 mile per hour speeds. As seen from figure 2, the maximum speed does not exceed 28 miles per hour. The corresponding stops from 40 miles per hour for the 1916 (AMUE) equipment are, 380 feet in 11 seconds for the emergency, and 580 feet in 16 seconds for service. For all other speeds the braking distances are assumed to vary as the squares of the speeds and the times directly with the speed. The time of station stop is taken in every case as 20 seconds. The station headways (Hs) of figures previously shown are the values used for the modern performance shown on the diagrams.

Figure 3 compares the "running" and "station" headways for modern equipment with those of 1906. The train length

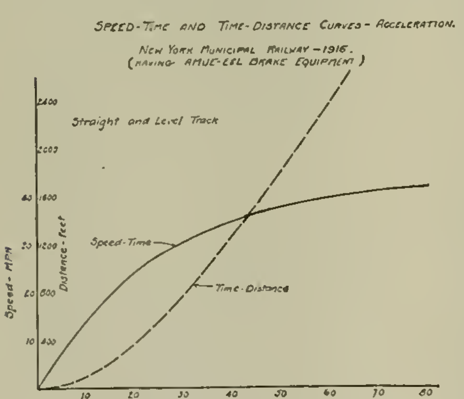


FIG. 1.

for each case is approximately the same, which eliminates any uncertainty due to the influence of this factor. The minimum "running" headway required for modern operation is only from 63% (at 60 miles per hour) to 65% (at 30 miles per hour) of that required for 1906 operation. The minimum "station" headway required varies from 63 to 72 per cent. in like manner. All of this may be summed up by saying that modern train control equipment has cut down the minimum headway required for the movement of trains to less than two-thirds of that required ten years ago.

It has also been demonstrated that as the station spacing is increased the traffic acceleration is also, which means in turn, that the traffic volume for any given period is enlarged. This is for the reason that the time spent running at the

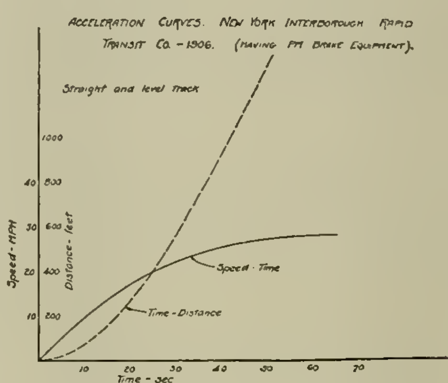


FIG. 2.

maximum speed becomes a larger portion of the total time a train is on the road, and the average speed over a given district becomes correspondingly higher, as the station spacing is increased. The practice of having train stops at alternate stations or groups of stations—"ship" stops, in other words—is based on this relation.

These curves also show that as the maximum running speed is increased the traffic acceleration becomes greater, but at a decreasing rate until finally, at some critical speed value, it actually starts to fall off with a continued increase in speed. The critical speed for the 1906 equipment and this station spacing is about 25 miles per hour, and that for the modern equipment is about 35 miles per hour. To operate at speeds greater than these critical values is actually to reduce the traffic acceleration and correspondingly the traffic capacity and as the station stops are spaced farther apart this critical value for speed becomes greatly increased.

Modern brake apparatus as compared with that of 1906 has permitted an increase of 50 per cent. in the number of trains to be handled with the same road-

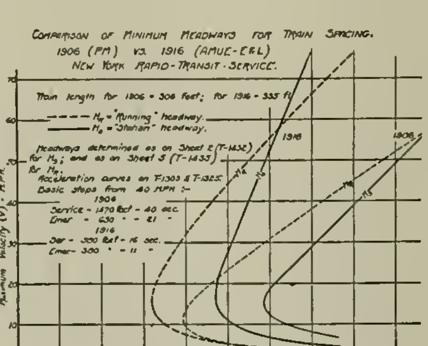


FIG. 3.

way facilities in the way of number of tracks. While it is true that modern motor equipment provides a higher maximum speed and a rate of acceleration somewhat better, the train length is also greater, contributing toward an increased headway for the modern conditions, other things remaining equal. This increased train length means more passengers per train, therefore the best over-all comparison of the efficiency of the brake is found in the relative passenger mile performance, and this shows a gain of from 300 per cent. to 350 per cent. with unchanged roadway facilities. This great advance in the transportation service, and therefore in the value of the railway property which carries this service, depends on more than anything else, the strides made in the science of train control, for the present status of this science

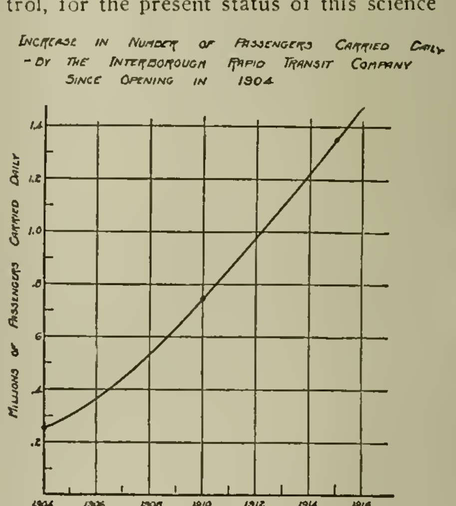


FIG. 4.

has rendered possible high rates of retardation started in trains of greatly increased length with a minimum loss of time, heavy cars with large load capacity, and greatly reduced headway between trains.

Figure No. 4 pictures the strides that have been made by the New York Interborough Rapid Transit Company in the number of passengers handled daily since its inception in 1904 and serves well as an interesting practical summary of the vital relation of train control to the value of railway properties. Trains cannot be moved unless they can be controlled. To turn loose the tremendous power of modern locomotives without adequate means for controlling it would be similar to generating a high steam pressure without suitable provision for containing it. The

effectiveness of control will determine the speed and number of trains. It will determine the number of cars which may be successfully operated in each train, as well as their weight and variation in weight, from the empty to the loaded condition. The word determine has been used, but as a matter of fact, the advancement in the science of train control, arising in the types of apparatus designed to meet ever-changing requirements, has kept pace with, and is actually abreast of, the increasingly severe operating conditions. Therefore the advancement in railroad efficiency which in this respect has placed us ahead of other nations, has been permitted rather than been determined by the progress made in train control equipment.

Further advancement will also be permitted in just the same degree that the railroads continue to avail themselves of the advantages offered by modern equipment for train control; that is, amazing strides in furthering the economic worth of railway properties, to the public and stockholders alike, can be made by applying intelligently to the science of train control for solution of the weighty traffic problems of this day.

The attempt of this paper has been to point out more the potential value of, rather than the absolute necessity for, improved types of train control apparatus. This is not intended to be a claim that increasing the capacity of a railroad by any means will increase the supply of business, whether the means be double-tracking, improved methods of train control, or any other. Increased capacity for a railroad no more increases the business of the railroad than does the enlarging of a tank increase the water it originally contained. Putting in a second pipe line does not add to the content of an oil well —it merely makes possible the transportation of a larger output if the larger output be there. Similarly, providing improved traffic facilities for a railroad will not supply the traffic, but such provision will meet increased traffic demands. And all may rest assured that the demands will always precede the extension in capacity. In short, the science of train control solves weighty traffic problems. Where there is no problem obviously there is no solution required.

Unfortunately, the significance of the problems themselves, quite apart from their solution, is not appreciated by many who are directly concerned with them. There are evil results attendant upon the use of the single-shoe-per-week type of foundation brake gear; the use of air brake devices in service far beyond their designed capacity; the operation of trains with effective braking ratios widely varying from one portion of the train to another, due to leakage, lack of uniform piston travel, car loading, etc.—upon all of these and many other malpractices.

The extent of the evil results herein arising is beyond the ken of only too many whose interest it is to know of this indirect tax—this improperly invisible drain on the economic wealth of our transportation systems and, therefore, finally, on the commonwealth.

In other instances these results are accepted by many railroad managers as a matter of course; as necessary evils indissolubly associated with the operation of trains, and to be paid for as unavoidable elements of the cost of transportation.

The purpose of this series of papers has been to review the factors involved in railroad capacity and to show that train control can be made the most effective and profitable of all (in fact, it is so now); still, there is as much to be gained in this direction as has already been done. Some say we are getting along all right with what we have, and this may be granted, particularly as regards safe operation, but safety is now being had largely at the expense of economy and capacity. Is this wise? Is the investor satisfied? I think not when I see such efforts as are being made to increase capacity by "bigger power," greater capacity cars, etc.—the larger factor being neglected for the smaller.

What we now use generally is good, but what only a few are using is better, as they have proved. All the factors should advance at an equal pace if a rounded-out return is to be had. It is not the intent to condemn the old train control systems any more than progress in any direction may be considered condemnatory of that which has served its time and has been the pioneer of a better thing.

Wherever increase in capacity of a road is the desideratum it will pay to give the train control factor the most intelligent consideration. In other words, I intend only to set this up as a business proposition to be considered according to strict business principles.

It is high time that due study and thereby due appreciation be given to the underlying, and, it is true, intricately interrelated causes for operating troubles, because their removal establishes an economic gain of a dual nature: First, the elimination of expense directly due to these troubles, such as damaged lading and equipment, delays, etc.; and, second, the extension in traffic capacity permitted without a corresponding increase in operating expense.

The adoption of adequate train control equipment will do more than any other means possible to remove operating troubles, and, with existing right-of-way facilities, to provide for the extension in traffic capacity which will make possible the realization of the utmost efficiency in that most wonderful of our industries, transportation by rail.

Questions and Answers

Locomotive Air Brake Inspection

(*Continued from page 192, June, 1918.*)

367. Q.—What would you think wrong if there was a leak at the direct exhaust port of the automatic brake valve when the brake is released.

A.—That the rotary valve of the automatic brake valve was leaking or that the triple valve slide valve of the control valve was leaking.

368. Q.—How can you tell the difference?

A.—By placing the brake valve handle on lap position, if the blow stops the leak is likely from the control valve, if it continues it indicates a leaky rotary valve.

369. Q.—What would be wrong if there was a leak from the safety valve of the straight air brake equipment?

A.—It would indicate that the reducing valve was out of order, that the safety valve was out of adjustment or that the piston valve seat of the safety valve was leaking.

370. Q.—How can you tell the difference?

A.—By noticing the brake cylinder gauge hand.

371. Q.—What pressure is this safety set to carry in the brake cylinders?

A.—To open at 53 lbs.

372. Q.—What pressure will be shown if the safety valve is out of adorder?

A.—53 lbs. or more.

373. Q.—What pressure will be shown if the reducing valve is out of justment?

A.—Less than 45 lbs.

374. Q.—How can it be ascertained whether the safety valve is leaking from its piston valve seat?

A.—There will be a leak when the pressure in the brake cylinders is considerably lower than 40 lbs.

375. Q.—What does a leak at the exhaust port of the straight air brake valve indicate at a time when both brakes are released.

A.—That the slide valve of the straight air valve is leaking.

376. Q.—What is wrong if there is a leak from this exhaust port only when the automatic brake is applied?

A.—The leather seat at the straight air side of the double check valve is defective.

377. Q.—What would be wrong if the brake could not be released with the straight air brake valve after an automatic application with the automatic valve on lap position?

A.—The control and retain pipes might be wrongly connected, or there might be some stoppage in the control pipe branch to the straight air valve or in the ports of the straight air valve.

378. Q.—What could be wrong if the automatic brake would not apply

with a service brake pipe reduction?

A.—The triple valve piston packing ring might be leaking or there might be a bad leak in the control valve reservoir.

379. Q.—What if the brake could not be applied either in service or emergency?

A.—Ordinarily it would indicate that the control valve was cut out, or that the control valve was broken or the brake pipe port stopped up.

380. Q.—What is the difference in the brake equipments E. T. and L. T. when the engines are in freight service?

A.—The brake pipe and main reservoir pressures are lower.

381. Q.—Are there any other changes in adjustments?

A.—No.

382. Q.—How can the adjustment of the safety valve of a distributing valve be determined when the brake pipe pressure is 70 lbs.?

A.—By moving the automatic brake valve to emergency position.

383. Q.—What will increase the application cylinder pressure to 68 lbs. in this position of the brake valve?

A.—A flow of air from the rotary valve seat of the automatic brake valve through the application cylinder pipe branch.

384. Q.—What will the pressure chamber and the application chambers equalize at with a full service reduction when the brake pipe pressure is 70 lbs.?

A.—50 lbs.

385. Q.—What pressure will they equalize at with an emergency application?

A.—They will not equalize.

386. Q.—Why not?

A.—The application chamber is not connected with the pressure chamber or application cylinder when the equalizing slide valve moves to emergency position.

387. Q.—What chambers equalize?

A.—The pressure chamber and application cylinder.

388. Q.—At what pressure?

A.—About 65 lbs.

389. Q.—Why do they equalize at a higher pressure than when the brake is used in a service application?

A.—Because the application cylinder volume is naturally smaller when the application chamber is not connected with it.

390. Q.—What is the object of this?

A.—To provide a higher brake cylinder pressure for emergency stops.

391. Q.—Is there any other difference in the locomotive inspection if it is in freight service?

A.—No.

392. Q.—Is the brake on the freight locomotive to be given as careful inspection as the brake on a passenger locomotive?

A.—Yes, the same Federal regulations apply regardless of the class of service the locomotive is in.

393. Q.—How does the brake inspection on a locomotive with the combined automatic and straight air brake compare with that of the locomotive with the E. T. equipment?

A.—It is made in the same general way with but a few exceptions on account of the difference in the brake valves and the brake operating valves.

394. Q.—What are the principal differences in the two brakes?

A.—The combined brake has the brake cylinders supplied from an auxiliary reservoir and when this pressure is depleted the brake releases, also the engine brake cannot be graduated off with the automatic brake valve.

395. Q.—What improvement is made with the E. T. brake with respect to the number of parts used?

A.—The brake is very much more flexible with considerably less apparatus.

396. Q.—What parts of the combined brake are dispensed with?

A.—Triple valves, auxiliary reservoirs, high speed reducing valves and the straight air apparatus on the engine and tender.

397. Q.—What parts remain on the tender?

A.—Only the brake cylinder and the brake rigging.

398. Q.—How is the brake inspection started on the engine with the combined brake?

A.—With the brake cylinder leakage test.

399. Q.—How is it made?

A.—By applying the straight air brake in full and returning the valve handle to lap position.

400. Q.—Where is the automatic brake valve handle at this time?

A.—In running position.

401. Q.—Is there any difference in the inspection under the running board?

A.—No.

402. Q.—Where is the first difference encountered?

A.—In the brake valve test.

403. Q.—What should happen on the first 5 lbs. brake pipe reduction?

A.—The brakes in the engine and tender should apply.

404. Q.—How much more brake pipe reduction should then be made?

A.—About 22 lbs.

405. Q.—What should this do?

A.—Open the high speed reducing valves on the engine and tender.

406. Q.—Why?

A.—This reduction should give a brake cylinder pressure of over 60 lbs.

407. Q.—What is wrong if the valves do not open?

A.—The brake cylinder piston travel is too long, the high speed reducing valves are out of adjustment, the auxiliary reservoirs are not of the proper size or they were not fully charged before the application.

408. Q.—How would too long a piston travel reduce the pressure that will be obtained in the brake cylinders?

A.—The longer the piston travel, the greater the brake cylinder volume which must be supplied from the auxiliary reservoir which is of a fixed size corresponding to the size of the brake cylinders used.

409. Q.—How much brake pipe reduction is required to produce 60 lbs. brake cylinder pressure from 110 lbs. brake pipe pressure if every part is properly proportioned?

A.—24 lbs.

(*To be continued.*)

Train Handling.

(*Continued from page* 193, *June*, 1918.)

390. Q.—How does a difference in brake cylinder piston travel materially change the retarding force or the speed of various cars in the train?

A.—The light reduction of from 5 to 7 lbs., may develop practically no air pressure that would be noticed on an air gauge in a brake cylinder with 9 inches piston travel while the same reduction may develop as much as 20 or 25 lbs. brake cylinder pressure or one-half of a full service application on a 5 inch travel.

391. Q.—Does what has been said concerning slack in freight trains apply to long passenger trains?

A.—Yes, the run in or run out of slack on the first application should be noted same as in freight service.

392. Q.—With a train made up of loaded express or mail cars at the head end, which way could the slack be expected to run when the brake was applied from the locomotive.

A.—Toward the rear.

393. Q.—Why?

A.—Because the greater percentage of retarding force would be set up at the rear.

394. Q.—For what reason?

A.—For the reason that there would be less load on these cars at the rear than on the loaded express cars at the front end.

395. Q.—What would be the difference in the percentage of braking ratio between the head end and the rear end if the cars at the head end were loaded with a load equal to their light weight?

A.—About 100 percent.

396. Q.—What is the passenger car braked at?

A.—Usually at 90 per cent of its light weight.

397. Q.—What does this mean?

A.—That the total pull in pounds of the brake shoes against the wheels is 90 per cent of the weight resting on the wheels or rather of the total weight of the wheel on the rail.

398. Q.—What would be the effect of doubling the weight on the wheel?

A.—Halving the percentage of braking ratio.

399. Q.—How so?

A.—The brake shoe pressure would then be but 45 per cent of the weight pressing the wheel to the rail.

400. Q.—How is the brake valve to be handled in making a train stop from a high rate of speed in passenger service?

A.—It depends upon the type of brake equipment in use, whether of the direct or graduated release and also upon the make up of the train and in a general way upon the condition of the track as to grade and curvature, but at a high rate of speed the brake cylinder pressure should be high at the beginning of the stop and be reduced with the speed of the train.

401. Q.—Does this hold good for stops in cases of emergency?

A.—No, in cases of emergency the idea is to retain the maximum brake cylinder pressure developed to the point of stop.

402. Q.—Are all modern types of brake equipments designed to do this?

A.—Yes.

403. Q.—Does the PM equipment retain the maximum brake cylinder pressure to the point of stop?

A.—No.

404. Q.—Why not?

A.—Because the high speed reducing valves reduce the pressure in the brake cylinders to 60 lbs. before a stop from a high rate of speed is made.

405. Q.—How much is the initial reduction for stopping trains from high rates of speed?

A.—It depends upon the type of equipment in use and the instructions that are issued for handling that particular equipment.

406. Q.—What were previous instructions governing the amount of brake pipe reduction?

A.—A 25-lb. brake application made at a high speed and in one reduction.

407. Q.—How has this been varied?

A.—By specifying that the initial application be made with a "split" reduction.

408. Q.—What is meant by the term "split"?

A.—That the application of the brake be made with one or more reductions?

409. Q.—For what purpose?

A.—To prevent a harsh change in slack that is likely to occur with modern passenger trains even if running at a fairly high rate of speed.

410. Q.—At what time is the slack to be permitted to adjust itself during such a stop?

A.—Between the first and second reduction in brake pipe pressure.

411. Q.—What is to be gained in the way of uniformity in brake cylinder pressure by making a heavy brake application when the speed is high?

A.—It tends to a uniformity in brake cylinder pressure regardless as to ordinary differences in piston travel, for if the reduction is sufficiently heavy the safety valves and high speed reducing valves will blow the pressure in all cylinders down to 60 lbs. per square inch.

412. Q.—How much of an initial reduction should be made with the ordinary length of passenger train, if the equipments are of the PM, UC, PC, or type J New York?

A.—Not less than 8 lbs.

413. Q.—How much for the second one?

A.—With no great differences in braking ratio between the different cars in the train, it may be as heavy as desired, but with heavily loaded express cars, it might be of advantage to make 5 or 6 lbs. more and after the brake pipe exhaust closes, the reduction may be continued and made as heavy as desirable.

414. Q.—How much reduction should be made for the initial one with LN equipment?

A.—About 6 lbs.

415. Q.—For the second?

A.—Another light reduction of two or three lbs.

416. Q.—And thereafter?

A.—As heavily as may be required.

417. Q.—Why may the initial reduction be made lighter with LN equipment than with PM equipment?

A.—Because L triple valves have quick service features which P triples have not.

418. Q.—How can the brake cylinder pressure be reduced as the speed of the train reduces with LN equipment?

A.—By graduating the brake off.

419. Q.—How is the brake valve moved to graduate the release?

A.—From lap to release for one second for the first graduation, and thereafter the graduations are to be made from lap to running position.

420. Q.—With a very long train, is it necessary to leave the handle in release position for more than one second?

A.—No, but the valve handle may be left in running position for another second before returning it to lap position.

421. Q.—What graduates the brake or rather what forces the triple valve back to graduated release lap position?

A.—The flow of air from the supplementary reservoir into the auxiliary reservoir when the triple valve is moved to release position.

422. Q.—What stops the flow into the auxiliary from the supplementary reservoir, during a graduation of release?

A.—The triple valve slide valve when the triple valve is moved away from release position.

423. Q.—What retains the brake cylinder pressure with the triple valve in graduated release position?

A.—The triple valve graduating valve which closes the triple valve exhaust port when it is moved to graduated release lap position.

424. Q.—How is the brake cylinder pressure reduced with the speed of the train with P.M. equipment?

A.—The brake is released when the speed of the train has reduced to 18 or 20 miles per hour and re-applied with a light reduction.

425. Q.—How light is the second application made?

A.—Merely enough to stop the train.

426. Q.—Is the brake held on to the stop?

A.—It is with trains of 10 and 12 cars or more, or if the train is on a descending grade at the time of the stop.

427. Q.—Why is the brake released with moderate lengths of trains on a level track, just before the train comes to a stop?

A.—To have the brake piston receding into the cylinders and the brake shoes merely against the wheels as the train comes to a stop.

428. Q.—For what purpose?

A.—To produce a smooth stop which may be done with a low brake cylinder pressure.

429. Q.—What is the disadvantage of a split reduction?

A.—It tends to lengthen the stop and thus consume a little more time for the stop, but it results in a smoother stop.

430. Q.—What is the disadvantage of a very heavy initial reduction at moderate rates of speed?

A.—It sets up the retarding effect too quickly and under certain conditions results in a shock to the train.

431. Q.—Would the brake valve ever be moved to release position when running along the road?

A.—Not except in actual cases of brakes sticking.

(To be continued.)

Car Brake Inspection

(Continued from page 193, June, 1918.)

374. Q.—What should be the percentage of braking ratio on a passenger car?

A.—Ninety per cent based on a 24-lb. drop in the pressure in the auxiliary reservoir.

375. Q.—Is there any time limit on this?

A.—It should be obtained in 7 seconds time during service operation.

376. Q.—What should be the emergency braking ratio?

A.—Not less than 150 per cent.

377. Q.—Is it possible to obtain this high emergency braking ratio?

A.—Yes, with modern types of air brake equipments.

378. Q.—What percentage of braking ratio is employed on freight cars?

A.—Usually 60 per cent.

379. Q.—What is it usually based upon?

A.—50 lbs. brake cylinder pressure.

380. Q.—What cylinder pressure is used for a base when the freight car is braked at 70 per cent?

A.—On 60 lbs. cylinder pressure.

381. Q.—Ordinarily the passenger car braking ratio is based on a brake cylinder pressure, what is this pressure when 90 per cent is specified?

A.—60 lbs. pressure.

382. Q.—Where is the actual retarding force obtained when a brake shoe is applied to a revolving car wheel?

A.—Between the wheel and the rail.

383. Q.—How is this found?

A.—By measuring the difference between the distance of two stops made with maximum braking force, one with the rail sanded and the other with the rails lubricated.

384. Q.—What is this retarding force called?

A.—The adhesion of the wheel to the rail.

385. Q.—How is this force calculated?

A.—From the weight pressing the wheel against the rail.

386. Q.—How does this force vary?

A.—With the condition of the rail.

387. Q.—What is the actual force in pounds of the adhesion of the wheel to the rail?

A.—From 15 to 30 per cent of the weight pressing the wheel to the rail, the actual amount depending upon the condition of the rail.

388. Q.—Explain this a trifle more fully.

A.—With a damp greasy rail the adhesion of the wheel to the rail may be as low as 15 per cent of the weight on the wheel and with a dry or sanded raid it may be as high as 30 per cent of the weight.

389. Q.—What is the force derived from pressing the brake shoe against the wheel usually termed?

A.—Brake shoe friction.

390. Q.—What is the force pressing the shoe against the wheel termed?

A.—Brake shoe pressure.

391. Q.—What does the brake shoe pressure result in?

A.—In developing a certain force tending to check the rotation of the wheel.

392. Q.—What is this force called?

A.—The coefficient of friction.

393. Q.—What is this force?

A.—A certain per cent of the pressure forcing the shoe against the wheel.

394. Q.—How does this force vary?

A.—With the speed of the wheel, with the force pressing the shoe against the wheel and with the time the shoe is in contact with the wheel.

395. Q.—What is the simplest way to measure this force?

A.—By the pull in pounds on the brake beam hanger.

396. Q.—What are the names of these two forces developed by the application of a brake shoe to a revolving car wheel?

A.—The coefficient of friction and the coefficient of adhesion.

397. Q.—Do they work in harmony or in opposition?

A.—In opposition.

398. Q.—In just what manner?

3.—The coefficient of friction is a force tending to check the rotation of the wheel and the coefficient of adhesion is a force tending to keep the wheel revolving.

399. Q.—What happens if the friction between the wheel and the rail is in excess of the friction between the brake shoe and the wheel?

A.—The wheel keeps on revolving.

400. Q.—What happens if the friction between the shoe and the wheel exceeds the friction between the wheel and the rail?

A.—The rotation of the wheel is stopped and the wheel slides along on the rail.

401. Q.—How wide is the variation in the coefficient of friction?

A. From 7½ per cent. at 60-mile per hour speeds to as high as 35 or 40% at the stop or slow speed of the wheel with light cars or light-weight equipment, but under modern conditions of high brake shoe pressures the average coefficient of brake shoe friction obtained is not over 10%; that is, of the force in pounds pressing the brake shoe against the wheel.

402. Q.—What is the only possible way that the coefficient of friction can increase after the brake is applied with full force?

A.—Through a decrease in the speed of the wheel.

403. Q.—How can the frictional force decrease, the speed of the wheel remaining constant?

A.—By an increase of the force pressing the shoe against the wheel or through the increase in the time the shoe is held against the wheel.

404. Q.—In what other way can it decrease?

A.—With an increase in the speed of the wheel.

405. Q.—By the coefficient of friction decreasing with an increase in the force pressing the shoe against the wheel, is it meant that the frictional force is lower for the higher pressure?

A.—No, the total amount of friction is greater for the higher shoe pressure but the coefficient of brake shoe friction does not increase in the same proportion with the brake shoe pressure.

406. Q.—Why not?

A.—Principally because of the higher degree of heat generated with the higher brake shoe pressure.

407. Q.—Technically, what is the work done by the brake in stopping a train of cars transformed into?

A.—Heat.

408. Q.—As an example, and to bring the results out in round numbers so that no more than a mental calculation will be involved, let us assume that a car weighs 88,888 lbs., resting on two four-wheel trucks and we wish to design a brake leverage to develop 90% braking ratio for service operation, what will be the braking force required for the car?

A.—90% of 88,888 lbs., or 80,000 lbs., when full service brake cylinder pressure is attained.

409. Q.—Assuming then that a 14-inch brake cylinder is to be used and that it will develop an even 10,000 lbs. pressure on the brake piston, what will be the total leverage ratio?

A.—Eight to one.

410. Q.—Why?

A.—Because the total pressure on the brake piston is multiplied 8 times to develop the brake shoe pressure necessary for full service braking power.

411. Q.—Assuming then that we have live truck levers 24 inches long, the distance from the force applied point to the fulcrum being 24 inches and the distance from the fulcrum to the beam connection being 6 inches and it is a lever of the second class, what is the proportion of the lever?

A.—Four to one.

412. Q.—If 5,000 lbs. pressure was then delivered to the force applied end of the live truck lever, how much pressure would be developed on the brake beam?

A.—20,000 lbs.

413. Q.—Why?

A.—Because the proportion of the lever has multiplied the force delivered by four.

414. Q.—If the cylinder lever then is 24 inches long, also the piston lever and the connecting rod between the levers is exactly in the middle of the levers, or if the distance from the force applied point to the fulcrum is the same as the distance from the fulcrum to the pull rod, how much force will be developed on the pul rod?

A.—10,000 lbs.

(To be continued.)

Government Warns Thieves.

The property protection section of the Railroad Administration has prepared a large poster to advise all concerned of the heavy penalties provided under the laws of the United States for stealing from, or tampering with railroad property. It is believed that the dissemination of this information will form a powerful deterrent influence to wrongdoers. The government shows that it means business by promising a vigorous prosecution of those to whom the crime can be brought home, and also searching investigation of suspected cases. The government is right. Transportation is a vital thing now-a-days, and any hampering of the shipments authorized by the Director General, is a form of impeding rightful national activity which should be put down.

Second Triennial Convention of the Brotherhood of Locomotive Engineers

The delegates to the second triennial convention of the B. of L. E. assembled in Cleveland, Ohio, for business not long ago and continued in session over two weeks. The convention was in many ways remarkable, both in attendance and enthusiasm. Nearly 400 were present and the hospitality of the citizens of Cleveland was unbounded towards the visiting delegations. The Women's Auxiliary closed the convention some days earlier, but many of their members remained until the close of the Brotherhood convention.

Grand Chief Warren S. Stone presided during the meetings, and in his recommendations advised conservation and thought in whatever legislation may be needed, and his lucid portrait of the eight-hour law contest and other movements of much importance since the 1915 convention met with the hearty approval of the delegates present.

A letter was received from President Wilson expressing his regret at his inability to visit the convention, and also expressing his very great confidence in the patriotism, as well as the capacity, of the locomotive engineers of the country.

Mr. Timothy Shea, acting president of the Brotherhood of Locomotive Firemen, was present by invitation and made an eloquent and forceful address, in the course of which he paid a very high compliment to the executive officers of the two organizations, stating that since the adoption of the Chicago joint agreement five years ago, the chief executives, Mr. Stone and Mr. Carter, ruled upon several hundred cases that were referred to them, and the most remarkable fact in connection with the entire situation is this, that not once have they failed to agree.

On Sunday, May 12, a non-sectarian public service was held in the B. of L. E. Auditorium, to which all were invited. Addresses were made by Grand Chief Stone, Mr. Fred Bauman of the Cleveland Twist Drill Company, and Mr. Homer Rodeheaver, "Billy" Sunday's choir leader. The services closed by the congregation singing, "The Star-Spangled Banner." At a subsequent service in the afternoon, First Grand Engineer W. B. Prenter spoke feelingly on the fact that since the last convention this nation, to which we owe our allegiance, has been swept into the whirlpool of conflict and strife in which practically the whole civilized world is now engaged, and we, as citizens of this nation, have been trying to do what is commonly expressed "our bit." It was fitting, therefore, Mr. Prenter said, that we should pause from the many activities of our convention and take this opportunity of expressing our loyalty and our fealty to our country. On April 15, 572 of the members were on the field of Flanders, and of that number 23 are now in their last resting place.

Mr. Stone also addressed the meetings, and in referring to the work of the Brotherhood he stated that the locomotive engineers were vitally interested in winning the war. When they talked about an increase in wages last winter, Mr. Stone said he told them first of all to decide whether we are going to have a country to railroad in or not, and then we will talk about wages later on. We have put all of our money that we could into bonds. We are all trying to help our Government, and doing with a heart full of gladness all that it is possible that we are able to. When the victorious soldiers come back they are coming back to a new world under new conditions, with a broader grasp of the many great problems that confront humanity than they ever had before. They are not going to be content to sit down in a little isolated spot here and be content with only a small share of their earnings. They are going to have more to say than ever before as to how this country of ours shall be managed and run. They are going to have their part in the progress of the world, and it is going to be a government of the people, by the people, and for the people, in which labor will have a prominent part.

In closing our report it may be said briefly that during the many days that the convention was in session, and the many social functions attendant upon the occasion, the spirit of patriotic fervor was of the highest and best. The business transacted was not conspicuously put forward, as may be expected, the great bulk of the routine work being done by special committees, and as is well known, this work goes on continually, so that there is no congestion of unsettled questions coming before the convention. This naturally induces a greater degree of harmony, and the proceedings as far as we were able to judge, took more the form of a series of ratification meetings, so that the convention altogether was, perhaps, the most harmonious that has yet been held. To this admirable end, Mr. Stone contributed largely by his masterly method of presiding over the deliberations of the delegates. As may be expected, his re-election to the office of president was a foregone conclusion, and the future work of the Brotherhood during the great national crisis in which we are involved may be confidently looked upon as calculated to contribute in no small degree to the good name of the worthy organization and the maintenance of the Government under which we live.

Traveling Engineers' Association.

The Railroad Administration has authorized the Traveling Engineers' Association to hold the next convention at Chicago, Ill., commencing September 10, 1918, and the following are the subjects to be discussed:

Fuel Economy under the following heads: (1) Value of present draft appliances; can they be improved to effect fuel economy? (2) Best practice for handling locomotives at terminals to reduce coal consumption. (3) How can enginemen and firemen effect the greatest saving of fuel when locomotives are in their charge? (4) Whether it is most economical to buy cheap fuel, at a low heat value or a higher priced fuel at a greater heat value. (5) The most economical method of weighing fuel when delivered to locomotives, in order that individual records of coal used by enginemen and firemen may be kept. (6) Superheat applied to locomotive as affecting coal consumption.

Engine Failures—causes and remedies, best methods of investigating same, and placing responsibility. The use of superheat steam in slide valve engines. Drifting, relief and by-pass valves or the absence of any one or all on superheat locomotives equipped with piston valves. Cab and cab fittings on modern locomotives, from the viewpoint of the engineman. How can the traveling engineer and general air brake inspector best co-operate to improve and maintain the air brake service? There will be some opportunity afforded for taking up such other matters as may be considered of interest.

Fire Lighters.

Experiments in London, England, on the subject of fire lighters has resulted in the approval of using five parts of resin and two parts of paraffin, being melted together and poured over four parts of wood chips, shavings, or sawdust. Four parts of coal dust are then added, the composition, after being well mixed, being poured into moulds. The moulds are shaped so as to form several briquettes joined together at their bases, but capable of easy separation.

Electrical Department

Converting of Alternating Current Into Direct Current—The Torque of a Motor

In many instances which we might give, direct current is required where only alternating current power is available. It is therefore necessary to convert the alternating current into direct current. This can be accomplished by three different methods: (1) By the use of the motor generator set. (2) By the use of the rotary converter or synchronous converter. (3) By the mercury rectifier. By each of the above-mentioned methods, direct current is obtained, but the operation in each case is different. Each method will be considered in detail.

The motor generator consists of two independent machines connected together on a common shaft. The motor which does the driving is an alternating current motor and may be of the induction or synchronous type. It is connected to the A. C. power supply. The generator supplying the direct current is a machine of the D. C. generator type and is entirely independent of the motor. There are no electrical connections whatever between the two machines and the relation is purely mechanical; the motor instead of driving the generator by a belt is direct connected to it by a coupler. Both machines are mounted on a common bed-plate and both machines form a convenient unit, which economizes floor space.

The rotary converter is different from the motor generator set in that the two

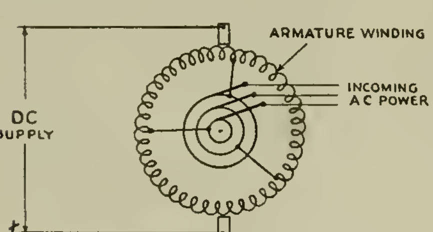


FIG. 1. CIRCUITS AND WINDING.

parts, that is, the motor and the generator, are embodied in one machine. In fact, there is only one rotor and one winding for both the A. C. and D. C. sides. The machine is a rotating one as is the motor generator set. The motor side of the machine is a synchronous motor which runs at constant speed under all loads, keeping in step with the electric generator at the power house. The arrangement of the circuits and windings, etc., is shown in Fig. 1. This diagrammatic sketch shows the one armature with a direct current commutator on one end and slip-rings on the other end. Fig. 2 shows how the slip-rings are connected to the armature winding. The winding on the armature is a closed winding, as illustrated by Fig. 2, and each ring is tapped in to this winding, separated so they are 120 degs. apart. Connections are brought out from this winding to the commutator exactly the same as in the case of a D. C. generator. The fields, as will be seen in Fig. 1, are excited

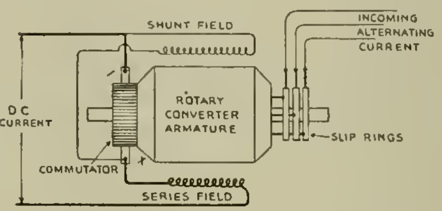


FIG. 2. SLIP RINGS AND ARMATURE WINDING.

or receive the current for their excitation from the direct current side. The alternating current voltage which for 600 volts supply on the D. C. side, is approximately 400 volts, is applied through the collector rings to the armature winding. The rotary then starts running, it comes up to speed and then operates as a synchronous motor. At the same time, on account of the rotation of the armature, the windings or conductors are cutting the lines of force from the fields which are placed around the frame. This voltage is commutated by means of the commutator and direct current is taken off by means of the carbon brushes. As explained before there is but one winding on the armature connected to both the commutator and the collector ring. Analysis of the floor currents in the armature winding shows that part of the current passes from the collector rings directly through the winding to the commutator and flows through but a part of the winding. A rotary converter has a certain approximate ratio between the alternating voltage applied and the direct current voltage delivered. The ratio differs slightly depending on the winding arrangement of the rotary and is either 0.615 or 0.707. That is, assuming that the D. C. voltage to be 1.0 and the A. C. voltage to be .615 or 0.707.

The mercury rectifier works on an entirely different principle than either of the above-named two pieces of apparatus. It is a stationary piece of apparatus and has no rotating parts. Moreover, it is a true rectifier. It acts as a switch, opening and closing alternate paths in such a manner that the two halves of the alternating current waves are transeformed into "unidirectional" waves without practically any loss, and thus the efficiency is extremely high. While commercially the mercury rectifier has not been built in large sizes like the rotary converter and the motor generator set, still it is used very extensively for small circuits especially for the charging of batteries. Large experimental mercury rectifiers have been designed using iron tanks. The small commercial rectifier consists of a hermetically sealed glass bulb filled with mercury vapor and provided with four electrodes. The arrangement is shown in Fig. 3. The two upper electrodes are of graphite or other suitable material and the two lower are of mercury. The graphite electrodes are called the Anodes; the main mercury electrode is called the cathode, and the small one is the supplementary starting electrode. The rectifier stands in the upright position as shown in the sketch, and the mercury pool at the cathode is of such a depth that the two lower electrodes are not in contact when the bulb is vertical. The bulb, however, is so mounted that it can be tilted to bring the two pools of mercury temporarily in contact for starting.

The entire bulb contains liquid mercury

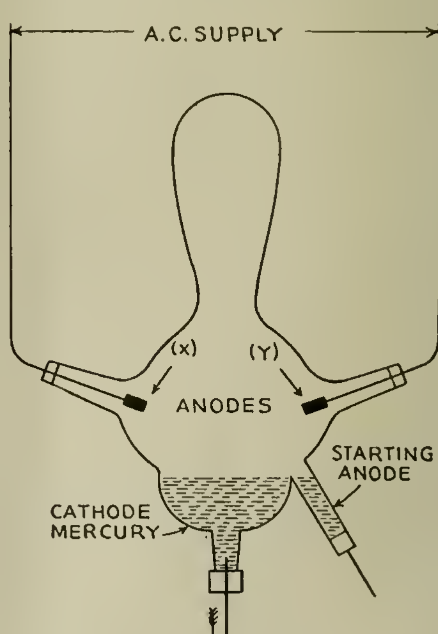


FIG. 3. SECTION OF THE MERCURY VAPOR RECTIFIER.

and the vapor of mercury which like many other metal vapors is an electrical conductor under some conditions. This vapor surrounds the anodes and has the property such that an electric current can pass from either of the solid electrodes to the mercury vapor and from it to the mercury electrode, but the current

cannot flow in the reverse direction, that is, it cannot pass from the mercury to the vapor and on to the anodes. This impossibility of flow in the reverse direction just mentioned is due to the high resistance at the surface of the mercury. The alternating current supply circuit is connected to the two anodes as shown in the diagram and as the anodes will allow current to flow only in one direction, the pulsations of the current pass alternately from first one and then the other of the anodes into the mercury. As these currents cannot pass back to the anodes, they must all pass out in one direction and that is through the mercury electrode, from which they emerge as a uni-directional current. This action can be compared to that of a check valve. The anode of a rectifier is practically a check valve permitting current to pass into the mercury vapor but preventing it from passing out.

This action of the mercury rectifier will be better understood by referring to the diagrams, Fig. 4. Alternating current, as we know, varies from zero to maximum and back to zero; reverses to negative maximum and back to zero, and this can be illustrated graphically by the wave forms Fig. 4a. We have shown that current can only pass from the anode to the mercury and taking anode (x) Fig. 3, the current shown in Fig. 4a cannot all pass from this anode, but only the current above the zero line, so that the

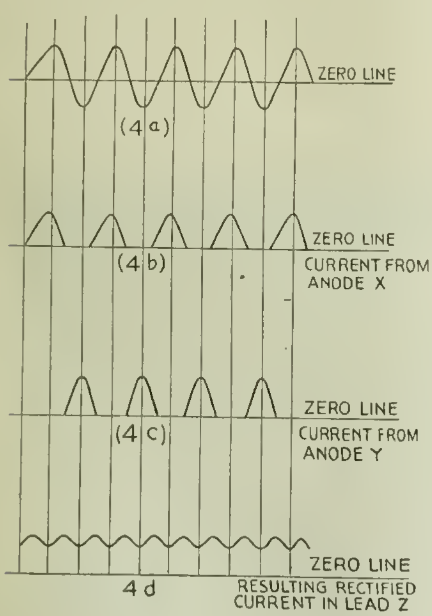


FIG. 4. DIAGRAM OF MERCURY VAPOR RECTIFICATION.

current flowing from the anode (x) to the cathode is shown by Fig. 4b.

The positive current passes from anode X to the mercury, but cannot pass through the vapor to anode Y. The negative current passes from anode Y to the mercury, but like the positive current, it cannot pass through vapor to anode X. Thus the flow of this current is from anode Y to the mercury and out of the cathode lead in the same direction as the current from the anode X. Therefore in reality the current is transposed above the zero line and the current flowing from anode Y is shown in 4 C. It is practically a direct current, slightly fluctuating. By means of a reactance connected in the outside circuit, the currents 4b and 4c are so changed that they overlap and there is resulting current shown by Fig. 4d. The pulsations are very slight and a comparatively smooth direct current is obtained. A complete circuit of a mercury rectifier is shown by Fig. 5. A transformer as noted is used to give the proper voltage.

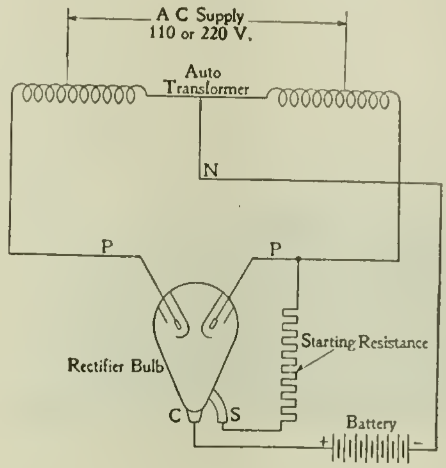


FIG. 5. DIAGRAM OF CONNECTIONS FOR BATTERY CHARGING.

Before the rectifier begins to "rectify" the alternating current there is a high resistance at the surface of the mercury which must be broken down so that the current can pass. This surface resistance is called the cathode resistance and acts like an insulating film over the entire surface of the mercury. The film must be punctured before any current can pass. When once started, the current will continue to flow, meeting with practically no resistance as long as the current is uninterrupted. Any interruption of the current, however, even for the smallest fraction of a second of time, permits the cathode resistance to re-establish itself which stops the operation of the bulb.

This resistance is overcome by tilting the bulb so that the mercury connects the cathode and the starting anode together. Current then passes between these two terminals and when the bulb is returned again to its vertical position, the connection of the mercury is broken, resulting in a spark which breaks down or punctures this film and the rectifier begins to operate.

The Torque of a Motor.

A dynamo-electric machine, usually called a dynamo (from the Greek Dunamis, power) is a machine for converting mechanical energy into electrical. The word motor (from the Latin, motere, to move, is generally understood to signify a machine which is used to change electrical energy into a mechanical form. Dynamos are generally divided into two classes, according to the current used. One is a direct-current dynamo, and the other is an alternating-current machine, or an alternator.

The direct current does not reverse, but the alternating current periodically reverses and flows in a series of pulsations, first one way and then the other. The number of these reverses per second is dependent on the number of poles which the machine has, and on the speed of rotation.

A direct current dynamo has its armature usually made by a series of conductor wires placed on the surface of a cylindrical casting or drum. The conductor wires are parallel to the axis of the drum. The cylindrical casting is mounted on a shaft, with bearings at each end and can be rotated. The conductor wires of the armature do not touch the poles, though in rotating, they pass close to them. Any even number of poles or electro-magnets (which they are) may be used, according to the size of the dynamo.

The torque of a motor (derived from the Latin torquere, to twist) is in mechanics the turning moment necessary to make the armature of a machine turn on its axis. Torque is usually expressed in foot-pounds and is the turning moment of a circle one foot radius, or two feet diameter. The circumference of a circle 2 ft. diameter is 6.2832 ft. The formula for the torque is

$$T = \frac{\text{H.P.} \times 33{,}000}{2\pi \times \text{R.P.M.}} = \frac{5{,}252\ \text{H.P.}}{\text{R.P.M.}}$$

dividing 33,000 by 2π or 6.2832 gives 5.252.

Since one H.P. is equal to 746 Watts it follows that W or the Watts used in the equation gives

$$T = \frac{5{,}252 \times W}{746\ \text{R.P.M.}} = \frac{7.04\ W}{\text{R.P.M.}}$$

so that 7.04 times the Watts, divided by the revolutions per minute (R.P.M.) gives the torque of the motor.

Electric Coaling Plant.

The Pennsylvania Railroad has awarded a contract to the Roberts & Schaefer Company, engineers and contractors, Chicago, for the installation of a 300-ton, two-track, automatic electric, reinforced concrete locomotive coaling plant and two separate "RandS" gravity sand plants of concrete construction for installation at Kane, Pa. A contract has also been given to the same company for the construction of a concrete 100 ton coaling plant at Rainey Junction, Pa.

Correspondence

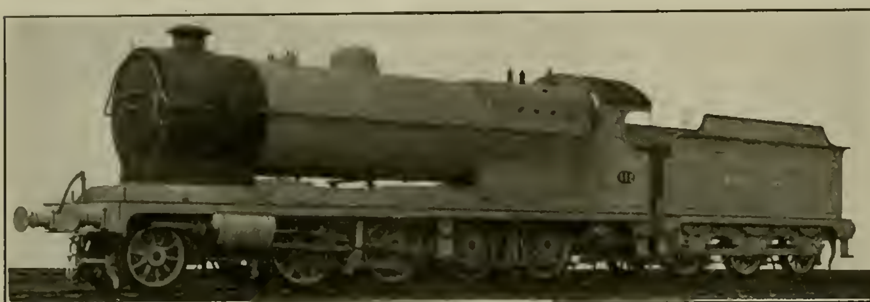
Standard Type of British Locomotive in France.

By R. W. A. Salter, London, England.

The British Ministry of Munitions has decided on the type of locomotive shown in our illustration, the first of a series of standard 2-8-0 locomotives, and are now being built at the Gaston shops of the Great Central Railway of England. This type of locomotive has already done unusually good service in France, and in addition to an extensive government order, no fewer than 335 of them have been ordered from various corporations. The boiler, 5 ft. 6 in. in diameter, has a barrel 15 ft. long. It is fitted with a Robinson superheater having 28 short return loop elements with anti-carbonizing steam circulation through the superheater, steam chests and cylinders; with pressure release annular valves on the piston valve heads; and with an Intensifore forced sight feed lubricator for the steam chests and cylinders. The leading pony truck has 6 in. total cross travel which, in conjunction with thin flanges on the intermediate and driving wheels, enables the locomotive to operate round sharp curves. In addition to having a steam brake on all the coupled wheels as well as on those of the tender, the vacuum ejector and train heating cock are fitted together with the necessary pipes to enable passenger cars to be worked if required. The tender carries 4,000 imperial gallons of water and 6 tons of coal, and is fitted with water pick-up apparatus. Other particulars are as follows:

Cylinders, two, 21 ins. dia., 26 ins. stroke. Tubes, superheater elements, 28, dia. 1¾ ins. out; fire tubes, 28, dia. 5¼ ins. outs; fire tubes 116, dia. 2¼ ins. outs. Heating surface, superheater elements 308 sq. ft.; fire tubes 1,641 sq. ft.; firebox 174 sq. ft.; total 2,123 sq. ft. Area of firegrate, 26 sq. ft.

From the latest accounts it appears that this type of locomotive is likely to become standard, at least during the war activities, as it possesses many qualities that are admirably adapted for the roads that are more or less of a temporary quality of construction throughout the wide war region.



BRITISH TYPE OF LOCOMOTIVE IN SERVICE FOR GREAT BRITAIN AND FRANCE.

Day Coach Turned Into a Sleeper.

By F. Kinney, Salt Lake City, Utah.

A device for transforming a day coach into a sleeper for military transport service has been invented by Mr. J. H. Covington, of Salt Lake City, who has offered it to the government as an aid in the movement of troops during the war. The ready adaptability of the appliance has been demonstrated on the Oregon Short Line, and orders have been placed for a number of cars to be equipped with the device on that road. The invention, as shown in the accompanying illustration, consists of a series of steel standards and frames adjustable to the seats of a day coach. The frames are provided with canvas, which serves as the base for the beds. The regulation sections of upper and lower berths, accommodating four passengers, are provided. The device may be so adjusted as to permit of the free use of the seats during the day time. Army officers who have seen the device demonstrated are of the opinion that it is likely to prove of particular value in relieving the heavy transportation demands on the Standard Pullman. The main parts being constructed of ordinary iron tubing, the cost is insignificant compared with the sleeping car equipment generally in use.

CORRINGTON'S DEVICE FOR TRANSFORMING A DAY COACH INTO A SLEEPER FOR MILITARY TRANSPORT SERVICE.

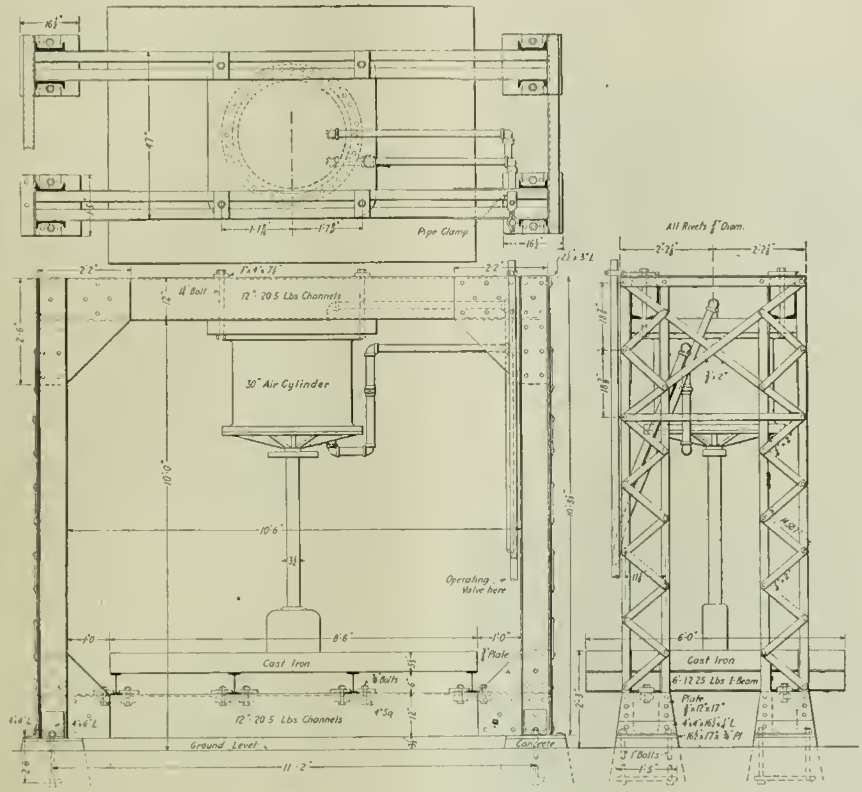
Pneumatic Press for Straightening Steel Sheets.

By A. C. Clark, Pittsburgh, Pa.

The accompanying drawing shows an elevation view of a pneumatic press for straightening steel sheets for steel cars, tanks, tenders, boilers and other appliances requiring straight sheets. It is conceded to be the best of its kind in use, and quite a number are already on the Pennsylvania and other railroads. In way of construction, it rests on four concrete piers, and on each pier is a ¾-in. plate, 16½ ins. by 17 ins., on top of which the cross channels, 12 ins.—20½ lbs. per ft. rest; also 8 in.-11¼ lbs. per ft. vertical channels. 4 ins. by 4 ins. angles and 4 ins. by 6 ins. angles. Two 1-in. bolts 2 ft. long are introduced in each pier, as is also the long plate 1 in. by 5 ins. by 17 ins., which is above the heads of the bolts, the upper ends of the bolts pass through the ¾-in. plate and the 4 ins. by 6 ins. angle plate.

The 12 ins. horizontal channels, of which there are four, 10 ft. 10 ins. long, are placed with flanges facing each other in the two pairs. Between these flanges the bolts are placed which hold the four 6 ins.-12¼ lbs. per foot I-beams rigidly in place by aid of the clamps shown, and on these I-beams the cast iron bed plate rests. This bed plate is 5½ ins. in thickness, 6 ft. wide and 8 ft. 6 ins. in length.

Directly outside of each of the 12 ins.-12¼ lbs. per ft. horizontal channels is a ⅜-in. plate, 20 ins. wide and 24 ins. in



DETAILS OF PNEUMATIC PRESS FOR STRAIGHTENING STEEL SHEETS.

height, which is riveted to these horizontally, and also to the upright channels as shown. Each pair of upright channels are rigidly latticed together by ¼-in. plates, and which are further strengthened at the top by ⅜-in. by 2 ins. pieces as shown. The cylinder is 30 ins. in diameter, with 3½ ins. piston rod. The cylinder is held up to four top channels by four 1¼-in. bolts, the plates being on the top of the channels. Air pipes are shown for raising and lowering the piston, and the exhaust pipe is also shown. The block on the piston rod is 7 ins. by 15 ins. by 12 ins., and is of cast iron. All rivets are ⅝ in. in diameter. The operating valve is attached to the admission pipe and, although not shown in the drawing, its location can be readily made at any suitable height.

The general dimensions of the press are 11 ft. 2 ins. between the centers of the piers in front, and 3 ft. 3⅛ ins. on the sides. The width across the top of the press is 4 ft. 7½ ins., and the height from the ground line, 11 ft.

It will be understood that there are four piers, the distances between which we have already mentioned, and it may be added that each pair of upright channels are rigidly latticed together by ¼-in. by 2 in. plates. There are eight of these plates, and the uprights are further strengthened at the top by additional ⅜-in. by 2 ins. pieces.

The Director General Speaks.

A comprehensive statement of policy was recently made public by the Director General. He declared the railroad administration's aims in order of importance are to win the war by moving troops and war material promptly, to give efficient service to the public, to promote sympathy and understanding among the railroad managements, employes and patrons and to apply sound business policies to railway operation.

"The policy of the United States railroad administration has been shaped by a desire to accomplish the following purposes, which are named in the order of their importance:

"First, the winning of the war, which includes the prompt movement of the men and material that the Government requires.

"Second, the service of the public, which is the purpose for which the railways were built and given the privileges accorded them. This implies the maintenance and improvements of railroad properties so that adequate transportation facilities will be provided at the lowest cost.

"Third, the promotion of a better understanding as between the administration of the railways and their two million employes, as well as their one hundred million patrons. Transportation has become a prime and universal necessity of civilized existence.

"Fourth, the application of sound economies, including: The elimination of superfluous expenditures. The payment of a fair and living wage for services rendered and a just and prompt compensation for injuries received. The purchase of material and equipment at the lowest prices consistent with a reasonable profit to the producer. The adoption of standardized equipment and the introduction of approved devices that will save life and labor. The routing of freight and passenger traffic with due regard to the fact that a straight line is the shortest distance between two points. The intensive employment of all equipment and a careful record and scientific study of the results obtained, with a view to determining the comparative efficiency secured.

"The development of this policy will, of course, require time. The task is an immense one. It is as yet too early to judge of the results obtained, but the Director General believes that progress has been made toward the goal. The official government staff, the officers and employes of the railways, have shown intelligence, public spirit, loyalty and enthusiasm in dealing with problems that have already been solved and in attacking those that still await solution.

Inspector of Motive Power

The United States Civil Service Commission announces an open competitive examination for senior inspector of motive power for men only, between the ages of 25 and 60. It is desired to secure a list of eligibles having several years of practical experience in locomotive construction and repair shops in locomotive operation, and in cost estimating of locomotive construction and repairs. Applicants should apply by July 16, for Form 1,312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

Economizing in Brass.

The Bureau of Mines announced the perfection of a type of electric melting furnace that may be revolutionary in the making of brass. Patents on this furnace, known as the Rocking electric furnace, have been taken out by the bureau and have been assigned to Secretary of the Interior Lane as trustee. The licenses to operate these furnaces under the patents, it is understood, can be obtained by making application through Van H. Manning, Director of the Bureau of Mines.

The Central of Georgia is to install an electric interlocking at Boundary street, adjacent to the Union passenger station at Macon, Ga. This station is used by the Central of Georgia, the Southern and the Georgia Southern & Florida. The machine will have 85 working levers. The contract has been given to the General Railway Signal Company.

Items of Personal Interest

Mr. Zack Burrell has been appointed assistant master mechanic of the Oregon Short Line, with office at Salt Lake City, Utah.

Mr. J. S. Allen has been appointed general foreman of the locomotive erecting shop of the Canadian Pacific at North Bay, Ont.

Mr. C. M. Rogers has been appointed supervisor of stationary plants of the Chicago, Rock Island & Pacific, with headquarters at Chicago, Ill.

Mr. A. B. Clark, formerly master mechanic of the Chicago Great Western at Oelwein, Iowa, has been appointed master mechanic at Des Moines, Iowa.

Mr. Frank Dice has been appointed road foreman of engines of the Santa Fe, with office at Clovis, N. M., succeeding Mr. Harry Blake, transferred to Topeka, Kans.

Mr. L. G. Plaisted has been appointed general foreman of the Rock Island, with office at Sayre, Okla., and Mr. S. E. Jones has been appointed erecting foreman at Shawnee, Okla.

Mr. Elliott Summer, formerly superintendent of motive power of the Central division of the Pennsylvania, has been appointed superintendent of motive power of the New Jersey division.

Mr. C. W. Matthews has been appointed master mechanic of the Cincinnati terminals at Kentucky division of the Louisville & Nashville, with office at Central Covington Shops, Ky.

Mr. Harry Beck has been appointed division foreman of the Santa Fe, with office at San Marcial, N. M., and Mr. W. H. Dillon has been appointed roundhouse foreman at Albuquerque, N. M.

Mr. J. M. Davis, formerly general foreman of the Kansas City, Mexico & Orient a Wichita, Kans., has been appointed to a similar position on the Colorado Southern, with office at Denver, Colo.

Mr. W. N. Alexander, formerly yard foreman for the Chicago Great Western at Council Bluffs, Iowa, has been appointed traveling electrical inspector, with headquarters at Oelwein, Iowa.

Mr. W. Wells, formerly district master mechanic of the Canadian Pacific, with office at Schreiber, Ont., has been transferred to a similar position on the Farnham division of the Quebec district.

Mr. C. W. Culver, formerly general foreman of the Central of New Jersey, has been appointed assistant master mechanic of the Lehigh and Susquehanna division, with office at Mauch Chunk, Pa.

Mr. A. R. Kipp, formerly mechanical superintendent of the Chicago division of the Minneapolis, St. Paul & Sault Ste. Marie, with office at Fond du Lac, Wis., has been transferred to Minneapolis, Minn.

Mr. James S. Hustis, president of the Boston & Maine, has been appointed district director of the United States Railroad Administration, in charge of New England Railroads, with headquarters at Boston, Mass.

Mr. E. P. Pfahler, formerly master mechanic of the Baltimore & Ohio, with office at Cumberland, Md., has been appointed mechanical engineer of the locomotive section, United States Railroad Administration.

Mr. Percy R. Todd, president of the Bangor & Aroostook, has been appointed assistant to district director of the United States Railroad Administration, and general manager of the Bangor & Aroostook, with office at Bangor, Me.

ELISHA LEE.

Mr. John Vass, formerly road foreman of engines of the Grand Trunk, at Battle Creek, Mich., has been appointed assistant master mechanic of the Ontario lines, with office at Allandale, Ont., succeeding Mr. J. R. Donnelly.

Mr. F. W. Fritchey, formerly of the Division of Locomotive Inspection, Interstate Commerce Commission, District 15, has been appointed superintendent of shops of the Wheeling & Lake Erie, with headquarters at Brewster, Ohio.

Mr. H. M. Oakes, formerly master mechanic of the Missouri, Kansas & Texas at Parsons, Kans., has been appointed master mechanic of the Chicago Great Western, with office at Oelwein, Iowa, succeeding Mr. A. B. Clark.

Mr. C. B. Mottice has been appointed roundhouse foreman of the Kanawha & Michigan, at Dickinson, W. Va., and Mr. W. S. Straw has been appointed night foreman at the same point, and Mr. John Smith has been appointed traveling foreman, succeeding Mr. Mottice.

Mr. Ross Anderson has been placed in charge of the new accessory plant of the American Locomotive Company, at Richmond, Va. The new plant is chiefly adapted for the production of piston valves, flexible staybolts, valve gears, and other of the lighter parts of locomotive equipment.

Mr. B. J. Bonner, formerly road foreman of equipment of the Chicago, Rock Island and Pacific, with headquarters at Herington, Kans., has been appointed supervisor of fuel economy of the East Iowa, Cedar Rapids and Minnesota divisions, with headquarters at Cedar Rapids, Iowa.

Mr. F. Connolly, formerly supervisor of fuel economy of the St. Louis, Kansas City Terminal, Kansas and El Paso divisions of the Chicago, Rock Island & Pacific, with headquarters at Herington, Kans., has now also charge of the Kansas and El Paso divisions, with the same headquarters.

Mr. H. MacFarland, formerly engineer of tests of the Santa Fe, and Mr. G. M. Davidson, formerly chemist and engineer of tests of the Chicago & North Western, have been appointed members of the inspection and test section of the United States Railroad Administration for the western railroad region.

Mr. W. S. Jackson, formerly master mechanic of the Erie, at Marion, Ohio, has been appointed mechanical superintendent with offices at New York, succeeding Mr. E. S. Fitzsimmons, resigned and Mr. R. V. Blocker, formerly general foreman at Huntington, Ind., has been appointed master mechanic, succeeding Mr. Jackson.

Mr. W. M. Punter has been appointed signal engineer of the Canadian Northern eastern lines, with headquarters a Toronto, Ont., and Mr. W. Adams has been appointed signal inspector at Port Arthur, succeeding Mr. H. E. McDonald, transferred to the Duluth, Winnipeg & Pacific, and Mr. J. J. Crowe has been appointed acting signal inspector at Edmonton, Alb.

Mr. Ralph Peters, president of the Long Island, has been appointed Federal manager of the road, with office at New York. Mr. Peters entered railway service in 1872, and has held many positions, chiefly in the operating departments of the Southern and Mississippi Valley Railroads. In 1905 he was appointed president of the Long Island Railroad and allied companies.

Mr. Eugene McAuliffe, president of the

Union Colliery Company, and formerly general coal agent of the Frisco Lines, has been appointed manager of the Fuel Conservation Section, Division of Transportation, of the United States Railroad Administration, and Major E. C. Schmidt has been appointed assistant to Mr. McAuliffe, who will have offices at Washington, D. C., and St. Louis, Mo.

Mr. Edward J. Pearson, formerly president of the New York, New Haven & Hartford, has been appointed Federal manager of the road. Mr. Pearson is among the leading railroad engineers of our time, having had extensive experience in almost every department of railroad engineering, particularly in the West and Middle West. He is a graduate of the engineering department of Cornell University, and in 1880 entered railway service on the Missouri Pacific.

Mr. A. J. Stone, formerly general manager of the Erie, has been appointed Federal manager of the same road. Mr. Stone was educated at the Elmira Business College, at Elmira, N. Y., and entered railway service on the New York, Lake Erie & Western in 1888, since which time he has been with that road and its successor, the Erie, passing through many positions, chiefly in the operating department. He was appointed general manager in 1913, which position he held until his appointment as noted above.

Mr. Frank B. Clifton, formerly division electrician of the Kansas division of the Chicago, Rock Island & Pacific, has been appointed division electrician of the Iowa and Des Moines Valley division, with headquarters at Valley Junction, Iowa; and Mr. Roy Smith, formerly division electrician of the Iowa and Des Moines Valley division, has been appointed division electrician of the Illinois division, with headquarters at Rock Island, Ill., and Mr. Don Baird, formerly electrician at Huntington, Kans., has been appointed division electrician of the Kansas division, with headquarters at Huntington, Kans.

Mr. Elisha Lee has assumed his new duties as Federal manager of the Pennsylvania Railroad and its directly operated eastern lines, including the Pennsylvania Railroad Lines East, the West Jersey & Seashore Railroad, and the New York, Philadelphia and Norfolk Railroad. Mr. Lee states that it is his intention to disturb as little as possible the present organizations of the various departments, in order that the advantages arising from the long-established relations of the officers and employees shall be preserved. It should be borne in mind that all are directly in the service of the Government, and that the work, though free from the hardships and dangers that the soldiers and sailors must face, is no less necessary for the welfare of the country and for victory in this war.

Mr. E. W. Smith, formerly master mechanic of the Philadelphia division of the Pennsylvania, with office at Harrisburg, Pa., has been appointed superintendent of motive power of the Central division, with office at Williamsport, Pa. Mr. Smith is a graduate of the Virginia Polytechnic Institute, and entered the service of the Pennsylvania as a special apprentice in 1906. His promotion was rapid, successively filling nearly every position in the motive power department, among others from 1913 to 1916 he was assistant master mechanic at the Altoona machine shops, from which position he was appointed assistant engineer of motive power in the office of the general superintendent of motive power at Altoona. In 1917 he was appointed master mechanic of the Philadelphia division, which position he held until his recent appointment as noted.

WALTER V. TURNER.

STEPHEN C. MASON.

Mr. D. F. Crawford has been elected vice-president of the Locomotive Stoker Company, with headquarters at Pittsburg, Pa. Mr. Crawford entered railway service on the Pennsylvania in 1882, and continued in the service of the company, and filled many positions, chiefly in the mechanical department, and in 1903 was appointed general superintendent of motive power of the Pennsylvania Lines west of Pittsburgh. In 1917 he was promoted to general manager of the Lines West. Mr. Crawford was president of the Master Mechanics Association in 1913, and in 1915 he was president of the Master Car Builders' Association. Mr. Crawford has been particularly interested in the improvement of mechanical stokers, and is the inventor of the Crawford underfeed stoker, which has met with much popular favor, particularly on the Pennsylvania Lines West.

The degree of Doctor of Engineering was conferred upon Mr. Walter V. Turner, manager of engineering for the Westinghouse Air Brake Company, by the University of Pittsburgh, at their annual commencement, in recognition of his valuable services to the engineering profession and to humanity. Mr. Turner is considered the foremost pneumatic engineer in the world, and has over four hundred (400) inventions, covered by U. S. patents, in use on most railways of the world and in many large industrial plants. One invention alone, viz., the "K" triple valve, is valued at twenty-eight million dollars ($28,000,000). In 1906, Mr. Turner installed a newly devised brake on the New York subway, which produced a quicker and shorter stop than any brake heretofore employed. The control valve, adopted by the New York Central Railway in 1909, and the universal valve, the first successful electro pneumatic brake ever devised, by the Pennsylvania Railroad in 1913, are inventions of equal importance. Mr. Turner is an American citizen, but he was born in Epping Forest, Essex County, England. He came to the United States in 1888; became secretary and manager of Lake Ranch Cattle Company, Raton, New Mexico, in 1893, was engaged by the Atchison, Topeka & Santa Fe Railway in 1897, where he developed his first patent; and entered the services of the Westinghouse Air Brake Company in 1903. He received the following appointments with the latter company—mechanical engineer, 1907; chief engineer, 1910; assistant manager, 1915, and manager of engineering, 1916.

Mr. Stephen C. Mason, formerly secretary of the McConway & Torley Company of Pittsburgh, has taken up his duties as president of the National Association of Manufacturers. Mr. Mason's entire business career has been confined to some branch of railroad work

He began on November 10, 1880, as a station agent in his home town, Lyndeville, Vermont. As soon as he took up the work he learned telegraph operating and before he was 20 years old was called to headquarters of the Connecticut & Passumpsic Railroad, and asked to assume the duties of local freight agent at the headquarters of the division. After the creation of the Interstate Commerce Commission, Mr. Mason applied for and secured a position with that body in Washington, first in the office of the auditor of the commission, where he had charge of the tariffs filed by the railroad companies. Upon the creation of the Division of Statistics, of which Professor Henry C. Adams was the head, Mr. Mason was placed in that department and remained there until 1896, when he occupied the position of assistant statistician. At that time he was offered a position with the McConway & Torley Company of Pittsburgh, which he accepted in January, 1896, and in whose service he has been continuously ever since. Latterly Mr. Mason, in addition to his business experiences, has taken an active part in all public affairs affecting the interests of the railroads. He is vice-president of the Steel Founders' Society of America, a member of the National Industrial Conference Board, representing the National Association of Manufacturers thereon, and is a member of the Chamber of Commerce of Pittsburgh. In addition, Mr. Mason is chairman of the finance committee of the Railway Club of Pittsburgh, a member of the Railroad Club of New York, the City Club of New York, and the New York Railroad Club.

Obituary

Alfred R. Miller

Alfred R. Miller, treasurer of the Canadian Westinghouse Company, Hamilton, Canada, died at his home in that city, recently. His whole business life was devoted to the interests of the Westinghouse Company. He entered their service as bill clerk in 1897, was promoted consecutively to head bookkeeper in 1903, acting assistant treasurer in 1904, assistant treasurer in 1907, and treasurer in 1917.

William Dewar Ellis.

Mr. William Dewar Ellis, president of the Schenectady Locomotive Works at the time that it was merged with the American Locomotive Works, died in New York, on May 23, aged 63 years. He succeeded his brother in the presidency of the company, and his father, Mr. John Ellis, was one of the founders of the Schenectady Locomotive Works.

Stephen L. Bean.

Mr. Stephen L. Bean, mechanical superintendent of the Atchison, Topeka & Santa Fe Coast Lines, died recently at Los Angeles, Cal. He was from New York and entered railway service as a machinist on the Wisconsin Central in 1874. He held many positions in some of the leading western railroads, and in 1903 was appointed master mechanic at the Santa Fe at Albuquerque, N. M., and in 1904 was promoted to mechanical superintendent of the Coast Lines, which position he held at the time of his death.

Railroad President's Son a Hero.

Railroad men and the sons of prominent railroad men have reason to be proud of the part they have taken in the present terrible war. The latest example we have noted is that of Daniel Willard, Jr., son of Mr. Willard, president of the Baltimore & Ohio Railroad. The information comes to us that in the fierce fight at Seicheprey young Willard displayed amazing coolness in manning his gun for five hours under terrible shell fire. Daniel Willard, Jr., is a Yale graduate and volunteered early in the war.

Retirement of James C. Currie.

Mr. James C. Currie, special representative of the Nathan Manufacturing Company for the last 22 years, has been entered on the retired list with a liberal pension and a warm expression of gratitude from the president and officers of the company. Mr. Currie entered the railroad service on the Pennsylvania in 1871, and was rapidly advanced to engineer in the passenger locomotive service running between New York and Philadelphia, with a perfect record for a quarter of a century. He was selected by the Nathan company as special representative in the Eastern States and occupied a unique position as demonstrator of injectors, lubricators and all of the constantly improved boiler attachments and brass work for which the company has been long noted. Mr. Currie was constantly engaged in addressing railroad clubs and classes, and his engaging personality lent a charm to his discourses, which, lightened with a fine sense of humor, were warmly appreciated by the railroad men generally and young engineers particularly. Mr. Currie was born in Scotland, and is a fine type of what are known as the Borderers. He graduated in the school of hard experience, in youth an athlete, in manhood an engineer and special instructor, in age a model of well preserved physique brightened by the consciousness of a life's work well done and properly appreciated.

Mr. Currie has occasionally visited his native land, and is hopeful when the war is over to make another visit after witnessing the triumphant return of the victorious American army to the United States, which he is positively assured it will do before this time next year.

Railroad Equipment Notes

The Canadian Northern has ordered 7,430 freight cars for fall delivery.

The Santa Fe is completing a modern roundhouse at Wellington, Kans.

The Lehigh Valley is arranging to build shops and a round house to cost $1,200,000, at Ashmore, Pa.

The United States Ordnance Department has ordered 150 ammunition cars from the American Car & Foundry Company.

The Long Island will erect a one-story engine shop, 33x100 feet to cost $15,000, at Sixty-fourth street and Eighth avenue, Brooklyn.

The Baltimore & Ohio let contract to erect a 22-stall roundhouse and 100 foot turntable at Grafton, W. Va., to cost $275,000.

The Chinese Government Railways have ordered 14 Mikado type locomotives for the Pekin-Mukden line from the Baldwin Locomotive Works.

The Juniata shops of the Pennsylvania Railroad completed 22 K4S passenger locomotives during May, establishing a new production record.

The Lehigh Valley has ordered 56 locomotives from the Baldwin Locomotive Works. Work on this order will probably be started in August.

The United States Railroad Administration has ordered 390 additional locomotives, of which the Lima Locomotive Works are expected to take 45, American Locomotive Company 245 and Baldwin Locomotive Works 100.

The Baltimore & Ohio has awarded contract to the Westinghouse, Church, Kerr & Company for the construction of shop buildings at Glenwood, near Pittsburgh, Pa., which will double the capacity of the company's repair facilities at that point.

The Chesapeake & Ohio will expend $500,000 for improvements and extensions to car and locomotive repair shops at Huntington, W. Va. The company probably will build an erecting shop and additional unit for machine shop. Work has begun on yard improvements at Huntington to cost $75,000 to $100,000.

The Pennsylvania Railroad, Western Lines, has contracted with the Union Switch & Signal Company for the complete installation of a 59-lever interlocking machine at Logansport, Ind. This machine will have 15 levers operating 16 switches and 8 derails and 25 levers operating 26 signals and 19 spare spaces.

Draft gears for Government cars will be furnished by the following companies: Standard Coupler Company, Sessions-Standard, 50,000; Westinghouse Air Brake Company, Westinghouse Type D-3, 20,000; Union Draft Gear Company, Cardwell, 15,000; W. H. Miner, 10,000; Keyoke Railway Equipment Company, Murray, 5,000.

Orders for 392,000 car axles are reported placed by the Government, divided as follows: 95,000 to the Carnegie Steel Company; 84,000 to the Illinois Steel Company; 149,000 to the Pollak Steel Company; 16,000 to the Laclede Steel Company; 18,000 to the Pittsburgh Forge & Iron Company, and 30,000 to the Midvale Steel Company.

The Chicago, Milwaukee & St. Paul is planning an extensive improvement at Ottumwa Junction, Iowa, on its Chicago-Kansas City line, where a large engine terminal is to be constructed. The new structures include an 18-stall roundhouse, an 85-foot terminal building, a water softening plant, a power house, water tanks and other structures.

The Illinois Central is to erect automatic block signals between Springfield, Ill, and Marine, 73 miles, at a cost of about $155,000, and between Princeton, Ky., and Ilsley, 18 miles, at a cost of about $51,000. A telephone circuit will be installed in the Grenada district of the Mississippi division between the division and general offices and the principal stations, at a cost of about $30,000.

The Missouri, Kansas & Texas will erect following buildings at Appleton City, Mo.: Roundhouse and foreman's office, one-story, 120 x 136 ft., cost $20,000; engine house, 188 x 37 ft., cost $9,650; roundhouse, office and washroom, one-story, 32 x 36 ft., cost $4,600; oilhouse and storeroom, one-story, 30 x 72 ft., cost $2,500; boiler and pumphouse, one-story, 24 x 32 ft., cost $3,200; eating and lodging house, one-story, 31 x 63 ft., cost $3,500.

The New York, New Haven & Hartford has ordered from the Union Switch & Signal Company the material for an electro-pneumatic push button machine for the operation of the switches and signals at the new Cedar Hill Classification yard, New Haven, Conn. The machine has 42 units for switch operations, 2 for signal operation and 4 spare spaces. The switches will be operated by direct acting electro-pneumatic switch movements with direct track circuits provided for detector locking.

Books, Bulletins, Catalogues, Etc.

Lubrication

Last month the Texas Company, 17 Battery Place, New York, published an excellent article on "Steam Cylinder Lubrication," by W. F. Osborne, which is well worthy of perusal as showing the enormous loss of power caused by an improperly lubricated cylinder. It is clearly set forth that if all of the poor grades of oils in use were replaced with good oils, a saving of 15 per cent could be made in the amount of fuel used for power purposes. This seems like a big estimate, but it should be understood that this excessive loss is not due to the actual difference in the coefficient of friction of good and poor oils, but rather to the wear and destruction of machine parts through the inefficient or incomplete lubrication film provided by poor or unsuitable oils. This wearing of bearings and cylinders increases the friction and likewise the amount of fuel necessary to develop the desired amount of power. Copies may be had on application to the company's New York office.

Finding and Stopping Waste in Modern Boiler Rooms

Volume II of the excellent series of books in reference to power plant management has just been published by the Harrison Safety Boiler Works, 17th street and Allegheny avenue, Philadelphia, Pa. It is a reference manual of text, charts and diagrams, carefully selected, from papers read before engineering societies, the latest books, articles in technical papers and the publications of the United States Bureau of Mines, all concisely presented for practical application, by owners, designers, managers and operators in securing and maintaining boiler plant economy. The work extends to 274 pages, with 213 illustrations, bound in flexible cloth. Price $1.00.

Women Employees on the P. R. R.

Mr. Elisha Lee, Federal manager, Pennsylvania Railroad Lines East, and New Jersey and New York connecting lines, issued a statement in regard to the rapid increase in the number of women employees, accompanied by a decrease in the number of men, which is particularly interesting on account of the rapidity of the change. In the last week in May there were 5,682 women employees, and in the first week in June, in a period of only ten days, this had increased to 7,227. Thus, in the period under consideration 1,545 more women were hired than had, in the meanwhile, left the service. As the total number of both men and women hired exceeded by 645 the number who were lost, these figures would indicate that during the ten days in question there had been a loss of exactly 900 male employees as against a gain of 1,545 female workers.

A New Belt Booklet

"The Proper Care of Belts" is the title of a new booklet gotten out by the Joseph Dixon Crucible Company. We suggest that engineers obtain a copy for their files. As long as the original condition of life and pliability of a belt is preserved it is worth its cost price. To neglect belts will result in a twofold loss: a waste of power due to the inefficiency of the belts, and increased cost due to frequent belt renewals. Just now, as never before, it is essential that belting be given careful attention. The booklet contains helpful suggestions for getting maximum results from belts, and in addition has several pages devoted to useful information of a general character. Those interested should write to the Joseph Dixon Crucible Co., Jersey City, N. J., Dept. 190-O, for a sample of Dixon's Solid Belt Dressing.

Fuel Economy

The engineering experiment station of the University of Illinois has just issued a 90-page booklet, printed in four colors, which shows that the average small power plant can save 15 per cent of its fuel by the exercise of greater care in equipment and operation. This means a saving of twelve or thirteen million tons per annum if applied throughout the country. The purpose of the publication, which is entitled "Fuel Economy in the Operation of Hand-Fired Power Plants," is to present suggestions in effecting greater fuel economy, and in determining the properties and characteristics of the coal purchased. The publication was prepared by a special committee of experts, and as only a limited supply of copies of this publication is available for free distribution, requests for copies should be directed to the Engineering Experiment Station, Urbana, Illinois, and should specify "Circular No. 7."

The Identifying Mark

The National Tube Company, Pittsburgh, Pa., has issued a finely illustrated poster emphasizing the fact that from prehistoric times any meritorious product has borne an identifying mark. The trade mark "National" is an assurance of a pipe of great strength and exceptional ductility; of uniform structure and quality; of full weight; and, most important of all, a proved durability. "National" is the identifying mark of a make of tubular material manufactured in a wide variety of sizes and types which fulfill or anticipate all wrought tubular requirements. There is not a "National" pipe for every tubular service, but in the qualities enumerated it is unequalled.

The World's Coal Supply.

If it be true that the domination of the world will rest with those nations that own or control the two most important natural resources—coal and iron—a somewhat startling sidelight is thrown on the great problems of the present century by Campbell's figures on the coal reserves of the world.

	Short tons.
Americas	5,627,823,500,000
Asia	1,410,487,600,000
Europe	864,412,600,000
Oceania	187,842,900,000
Africa	63,755,900,000
	8,154,322,500,000

The portion falling to the United States alone is 4,205,154,000,000 tons, or over half of all the coal in the world.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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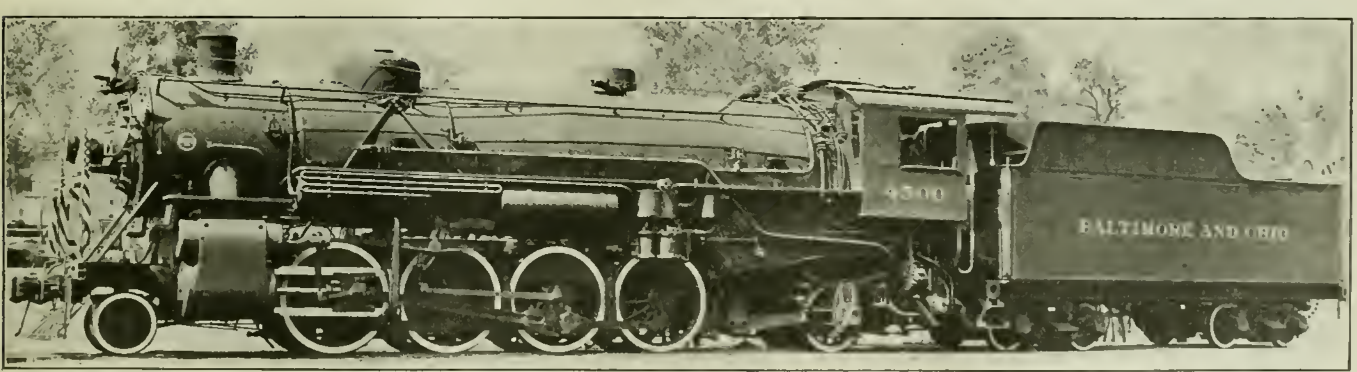
Baldwin Locomotive Works Completes the First of the United States Standard Locomotives

Mikado Type, 2-8-2, Assigned to the Baltimore & Ohio

It is interesting to learn that the first of the standardized locomotives ordered by the United States Government was completed by the Baldwin Locomotive Works on July 2, and is illustrated herewith. It is of the Mikado (2-8-2) type, and is one of the lighter series of locomotives carrying approximately 55,000 pounds on each pair of driving-wheels. The tractive force exerted is 54,600 pounds. This particular locomotive is one of a number that will be assigned to the Baltimore and Ohio R. R., and it has been lettered accordingly.

There is nothing radically novel about the construction of this locomotive. It represents modern practice for an engine of its type and size, and is equipped with fuel and labor saving devices; while the wheel loading is such that locomotives of this design can be operated on the greater part of the railway mileage in the United States.

The boiler has a conical wagon-top in the middle of the barrel, which increases the shell diameter from 78 in. at the first ring to 90 in. at the firebox throat. All road engines in the standardized series have combustion chambers and large furnace volume. The tubes vary in length from 19 ft. 0 in. in the Mikados and Pacifics, to 24 ft. 0 in. in the Mallets. In this locomotive the combustion chamber has a length of 24 ins., and the boiler is fitted for coal burning. The equipment includes a brick arch, mechanical stoker, and power operated fire-door and grate shaker. Flexible bolts are applied in the breaking zones in the sides and back of the firebox. They also stay the entire throat, and are used in the water space surrounding the combustion chamber, and in first four rows of combustion chamber crown stays.



MIKADO TYPE LOCOMOTIVE FOR THE UNITED STATES GOVERNMENT AND ASSIGNED TO THE BALTIMORE & OHIO RAILROAD
U. S. Government, Designers. Baldwin Locomotive Works, Builders.

The cylinder castings are secured to the smoke-box, and to each other, by double rows of bolts, and are attached to the frame rail, on each side, by ten horizontal bolts 1½ inches in diameter. Gun iron is used for the cylinder and steam chest bushings; also for the piston and valve bull rings and packing rings, and for the cross-head shoes. The piston heads are of rolled steel, with a dished section; and the cross-head guides are of the alligator type. The stub on the back end of the main rod is of the strap type, with removable brasses. A simple design of Walschaerts motion is applied. The combining levers are short, and the union links are attached directly to the cross-head wrist pins, thus saving the weight of separate cross-head lugs. The valve motion is controlled by power reverse mechanism, so arranged that it can be operated by either steam or air.

The frames are of substantial construction, as the main sections have a width of 6 inches, and a depth over the pedestals of 6⅝ inches. Transverse braces are applied at the first, second and third pairs of pedestals, and the upper frame rails are braced by the guide yoke and valve-motion bearer, and by a waist sheet cross-tie placed midway between the main and rear drivers. The pedestal shoes and wedges are of bronze. Instead of separate rear frames, a one-piece, cast steel cradle is used, and is bolted to the main frames immediately back of the rear driving-pedestals.

The front truck is of the constant resistance type, and the rear truck is of the Hodges type. The equalization system divides between the second and third pairs of driving-wheels, and the spring rigging is cross-equalized back of

the rear drivers. Flanged tires are used throughout. The lateral play between rails and flanges is ⅛ in. greater on the front and rear driving wheels than on the two intermediate pairs, and the swing of the trucks is sufficient to enable the locomotive to traverse 19-degree curves.

The tender is carried on arch-bar trucks, with cast steel side frames and rolled steel wheels. The tender frame is a one-piece steel casting. The design is such that a water scoop can be subsequently applied, if necessary.

Special attention has been given to the arrangement of the cab details and other equipment, so that the locomotive can be conveniently handled by the engine crew. The cab is of steel, lined with wood. To keep within the clearance limits, the bell is mounted on the smokebox front, and the headlight on the center of the smokebox door.

The materials of which the standardized locomotives are being built, conform to specifications issued by the American Society for Testing Materials. The following are the leading dimensions of the locomotive described above.

Gauge, 4 ft. 8½ ins.; cylinders, 26 ins. by 30 ins.; valves, piston, 14 ins. diam. Boiler—Type, conical; diameter, 78 ins.; thickness of sheets, 11/16 in. and 25/32 in.; working pressure, 200 lbs.; fuel, soft coal; staying, radial. Fire Box—Material, steel; length, 114⅛ ins.; width, 84¼ ins.; depth, front, 83½ ins.; depth, back, 61 ins.; thickness of sheets, sides, ⅜ in.; thickness of sheets, back, ⅜ in.; thickness of sheets, crown, ⅜ in.; thickness of sheets, tube, ½ in. Water Space—Front, 6 ins.; sides, 5 ins.; back, 5 ins. Tubes—Diameter, 5½ ins. and 2¼ ins.; material, steel; thickness, 5½ ins. No. 9 W. G., 2¼ ins., No. 11 W. G.; number, 5½ ins., 40; 2¼ ins. 216; length, 19 ft. 0 in. Heating Surface—Fire box, 259 sq. ft.; tubes, 3497 sq. ft.; firebrick tubes, 27 sq. ft.; total, 3783 sq. ft.; superheater, 882 sq. ft.; grate area, 66.7 sq. ft. Driving Wheels—Diameter, outside, 63 ins.; diameter, center, 56 ins.; journals, main, 11 ins. x 13 ins.; journals, others, 10 ins. x 13 ins. Engine Truck Wheels—Diameter, front, 33 ins.; journals, 6½ ins. by 12 ins.; diameter, back, 43 ins.; journals, 9 ins. x 14 ins. Wheel Base—Driving, 16 ft. 9 ins.; rigid, 16 ft. 9 ins.; total engine, 36 ft. 1 in.; total engine and tender, 71 ft. 4½ ins. Weight—On driving wheels, 221,500 lbs.; on truck, front, 20,200 lbs.; on truck, back, 49,100 lbs.; total engine, 290,800 lbs.; total engine and tender, about 463,000 lbs. Tender—Wheels, number, 8; wheels, diameter, 33 ins.; journals, 6 ins. x 11 ins.; tank capacity, 10,000 U. S. gals.; fuel capacity, 16 tons; service, freight.

Relative Economy of Locomotive of 1900 and Today

By JOHN E. MUHLFELD, before the American Society of Mechanical Engineers

At the meeting of The American Society of Mechanical Engineers, held at Worcester, Mass., recently, sessions were held for the discussion of the all-important subject of fuel economy. Mr. John E. Muhlfeld, the well-known railway engineering expert and president of the Locomotive Pulverized Fuel Co., presented a special paper bearing on the relative economy of the Locomotive of 1900 and today, wherein he stated that prior to 1900 considerable development work had been done on two, three and four cylinder types of compound locomotives by Mallet, Webb, Pilkin, Mellin, Vauclain and others. Pilkin's two-cylinder system was applied to a Michigan Central ten-wheel locomotive in 1889, and Vauclain's four-cylinder system was first introduced on a Baltimore & Ohio eight-wheel locomotive, No. 848, in October of the same year. These and other developments caused the adoption of both of the two and four-cylinder systems in new locomotives, the maximum application being reached during 1904, when approximately 1,000 two-cylinder, and 2,000 four-cylinder compound locomotives were in existence.

Previous to 1900 Schmidt, Pielock and others had done considerable experimenting with superheated steam, the former having succeeded in 1894 in producing a boiler and motor in which superheated steam of relatively low pressure was used at about 700 deg. Fahr. The failure of the compound locomotive to produce the economy predicted—due largely to the factors of indifferent design, lack of proper maintenance and operation, cheap fuel and road failures—resulted in the general return to the single expansion cylinder locomotive, and this with the demand for greater steaming capacity per square foot of boiler heating surface, naturally brought about consideration of ths use of superheated steam. The results of further experiments by Vauclain, Vaughn, Horsey, Cole, Emerson, Jacobs and others, along the lines of high and low degrees of superheat, in combination with either high or low steam pressures, by means of smokebox, fire tube, or a combination of both types of superheaters, resulted in the fire tube type being now practically a standard part of all new equipment, and it is further being rapidly applied to existing saturated steam locomotives in the United States.

STEAM LOCOMOTIVES IN THE UNITED STATES SINCE 1900.

Year	Item	Single expansion cylinder	Two-cylinder compound	Four-cylinder compound	Mallet articulated compound	Total locomotives
1900	Number .	36,600	1,000	900	...	38,500
	Ave. trac. power, lb.	19,000	28,000	29,000	...	...
	Ave. wt. on drivers, lb.	85,000	125,000	130,000	...	...
1905	Number* .	48,949	900	1,800	1	51,650
	Ave. trac. power, lb.	23,000	31,000	32,000	75,000	...
	Ave. wt. on drivers, lb.	100,000	140,000	145,000	335,000	...
1910	Number†.	56,425	875	1,500	200	59,000
	Ave. trac. power, lb.	27,000	31,500	40,000	72,000	...
	Ave. wt. on drivers, lb.	120,000	142,000	175,000	320,000	...
1915	Number‡.	62,000	650	1,300	800	64,750
	Ave. trac. power, lb.	30,500	32,000	33,000	79,000	...
	Ave. wt. on drivers, lb.	135,000	145,000	148,000	350,000	...

*Includes 1 superheater locomotive.
†Includes 300 superheater and 3000 oil-burning locomotives.
‡Includes 14,000 superheater and 4250 oil-burning locomotives.

While the Cole and Vauclain balanced compound types of locomotives as brought out since 1900—along the lines of the French De Glehn system—have not made much progress, the Mallet Articulated Compound system, introduced on the Baltimore & Ohio in 1904, is now in use on over fifty railways in the United States, and aggregates more than 1,500 locomotives. This latter type of locomotive not only permits extreme concentration of great power over a flexible wheel base within axle-load limits, but also reduces the stresses by greater distribution and lightness of parts, and through the combination of high-pressure superheating, compounding, simpling and reduction of unbalanced pressure gives the maximum direct and reserve tractive power for from 25 to 35 per cent. less fuel and water consumption per ton-mile than a superheated single-expansion locomotive.

With regard to the present status of the relative economy of steam and electric locomotives in the United States, as compared with the results obtained in 1900, general conditions have very substantially changed and the predominating factors today are manual labor and fuel for operation. While the inauguration of the use of fuel oil on almost 4,500 steam locomotives has somewhat improved the firing and steam-generation conditions, the increasing cost and demand for oil for more essential purposes and the reducing supply will soon make its use for locomotive fuel prohibitive. However, the use of oil as a locomotive fuel has long since demonstrated that the mechanical feeding and burning of fuel in suspension, whether gaseous, liquid or solid, for the production of steam in a self-contained motive-power unit, is the most logical, successful, effec-

tive and economical method for generating power and moving long-haul heavy-tonnage traffic on railways.

Even where hydroelectric power is available the self-contained steam-power-plant locomotive will show a much lower cost for fixed charge, maintenance and operation than the electric unit, as the transmission and conversion of electric current into drawbar hauling capacity is a very wasteful and expensive process in the present state of the electrical art. In fact, the principal economies brought about in the electrical field during the past quarter century have been in the production and use of steam for the generation of current and not in the electrical apparatus.

As applied to a long-haul railway, the metering and conveying of extremely high-voltage current from various power-plant sources into transmission mains, through switching sub-stations, transforming and converting, conveying to contact lines and converting into great hauling capacity at the draw-bar results in enormous line and bonding dead losses, which will bring the cost of even hydroelectric current per drawbar horsepower hour to from 6 to 7 mills. This cost, which, in combination with copper limitations, fixed train speeds up and down grades, general tie-up of operation in case of failure, and like factors, will hardly admit of comparison with steam-locomotive boilers operating at equivalent to 700 per cent. of the rated capacity of stationary boilers, with a 75 per cent. combined furnace, boiler and superheater efficiency, and furnishing a boiler horsepower for each 1½ sq. ft. of evaporating surface and producing a drawbar horsepower-hour for 2¼ lb. of coal.

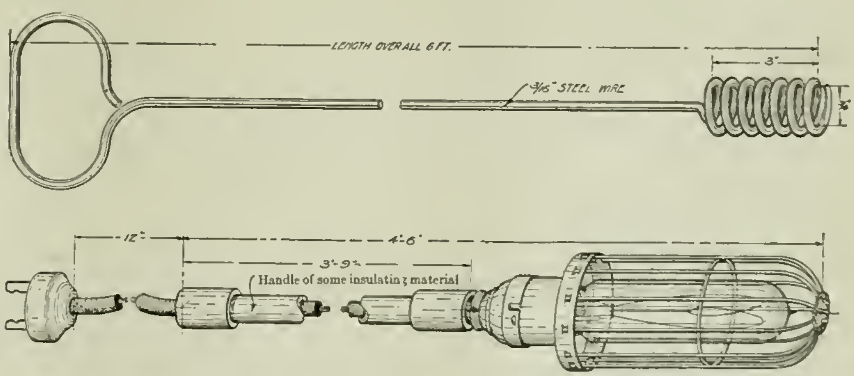
Nevertheless, the steam locomotive is still in its infancy so far as economy per ton-mile is concerned. The atomization and burning of liquid or solid fuels in suspension will enable the elimination of grates and other metal work from the combustion zone and permit of higher furnace temperatures and more complete and effective combustion, which, in combination with higher steam pressures; compounding; higher superheating of both high and low-pressure steam; utilization of waste gases and steam for feedwater heating and purification; better boiler-water circulation; reduced cylinder clearances and back pressure; improved steam distribution; lower factor of adhesion; higher percentage of propelling to total weight; less radiation; elimination of unbalanced pressures and weights; application of safety and labor-saving devices, and the greater refinement and perfection of general and detailed design, equipment and control throughout, will yet enable it to produce a drawbar horsepower-hour for one pound of coal.

Furthermore, it is not inconsistent to now predict that a self-contained steam-electric articulated compound locomotive, combining the advantages of both steam and electric motive power, will shortly find a useful field in services where maximum power and efficiency at high speeds; greater utilization of existing waste heat; high starting and low speed torque and rapid acceleration are required and where an exclusive electrification system would not be permissible from the standpoint of first cost or justified on account of the combined expense for operation and maintenance.

Running Repairs of Locomotive Boilers, and Approved Methods of Wash-Out of Boilers

In these strenuous days of railroad transportation involving long hauls, increased tonnage and high speed, it is gratifying to observe from the reports of the recent committees and meetings of railroad men that much attention has been given to the maintenance and care of locomotive boilers. With improved appliances many difficulties have been overcome, particularly since the introduction of autogenous welding by means of which the expense of repairing has been reduced to a minimum. The designs and construction of locomotives have also been vastly improved, and the best engineering minds in the country are constantly engaged in still further advancement. It seems, however, that in some of the more elemental requirements of the service there is need of a greater degree of earnestness in boiler maintenance. It has been frequently pointed out that scale formation in the boiler, which is inevitable, if permitted to assume any measurable degree of thickness is perhaps the greatest obstacle to advancement in the problem of fuel economy. The estimates furnished by experts as to the effect of certain thicknesses of scale in boilers is very conflicting, depending as it does on the degree of hardness of the scale or heat-resisting qualities, but all agree that the effect is by far greater than the degree of attention that is given to its remedy. Mr. Frank McManamy, formerly chief Federal inspector of locomotive boilers, and now head of the Division of Locomotive Maintenance, claimed at the recent Convention of the International Railway Fuel Association that 1/16 in. of scale will increase the fuel cost approximately 15 per cent., and that ¼ in. of scale will increase the fuel cost 60 per cent. His figures seem high, but his estimate remains unchallenged, and he has had excellent advantages in collecting reliable data.

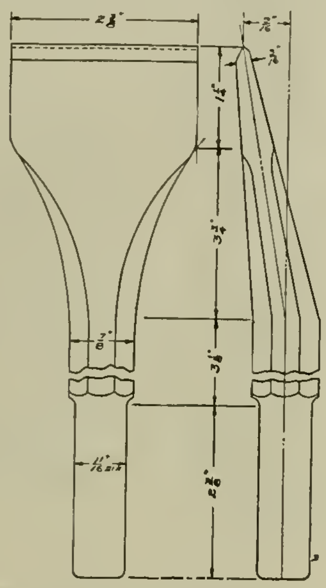
As to the efforts made by the leading railroads in recent years on the matter of boiler washing, it may be stated briefly that from recent reports it appears that 9,760 made less than 500 miles between wash-outs, while 11,283 engines made less 1,000 miles; 8,312 engines made over 1,000 miles, and less than 1,500 miles, and 20,472 engines made over 1,500 miles. The passenger locomotives make 30 per cent. greater mileage between wash-outs than freight engines. The average number of wash-out plugs in modern locomotives is 32. Washing out with hot water costs 35 per cent. less than with cold water. Roads using water-softening plants report over 100 per cent. gain in mileage as compared with untreated water. The average cost of washing out with cold water is $4.50, and with hot water about $3.00. The incrusting matter in boiler waters consists almost entirely of carbonates of lime and magnesia and sulphates of lime



BOILER INSPECTION TORCH AND ELECTRIC LIGHT.

and magnesia. The carbonates require treatment with hydrated lime, and the sulphates require soda ash.

While this data is of real value as showing a condensed reflex of the general practice in recent years, there is little data regarding the actual time occupied in the operation, but on the contrary there is abundant evidence of a pressing desire to make the operation as cheap as possible as if the lessened cost was the sole object to be aimed at instead of that absolute degree of thoroughness which should be the real object in view. Those who have had opportunities of observing the condition of boilers that have been some time in service cannot have failed to observe that while a large area of the boiler surface as well as the flues are comparatively free from any accumulated degree of scale, other parts, particularly certain kinds and forms of crown sheets may have been allowed to become considerably incrusted, showing that the operation has not received that intricate degree of attention to details that it demands.



TOOL FOR SCALING SHELL.

A word or two may be said in regard to shop organization and its bearing upon boiler maintenance before we take up the matter of boiler cleaning or washing, as a great deal depends on the proper handling of the routine work in running repairs. After the locomotive has been turned out of the shop, and before being placed into active service, the roundhouse inspectors should make a thorough inspection of the front end appliances, ash pan and grates, in order to ascertain if they have been properly applied and are in perfect condition. This is very essential in order to avoid engine failures, due to being improperly drafted or having some defect develop in the newly applied front end rigging or grates. A like inspection should be made after each trip and a report made on regular form showing condition. Any defect reported should be repaired immediately.

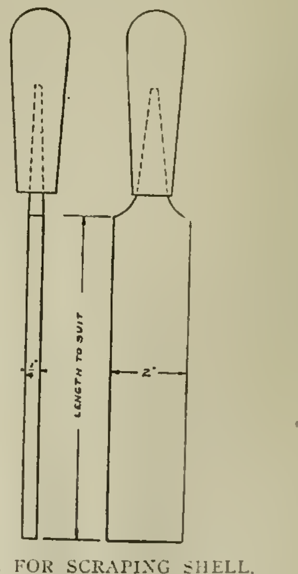
The cleaning of flues is a very important factor in locomotive performance, as stopped-up flues will cause a poor steaming engine. Whenever an engineer reports steam pipes leaking, engine not steaming, the flues should be examined to make sure that they are clean, as almost invariably the conditions referred to are due to stopped-up flues. The proper method of cleaning flues is with the auger and compressed air. Flues should be thoroughly blown out with air at the termination of each trip. When flues are stopped up they should be bored out with an auger of sufficient length to reach from end to end and then blown out thoroughly with air. Special attention should be given to flues in superheated locomotives. In locomotives with brick arches the bottom flues should be maintained in clean condition, and no locomotive should be allowed to go into service with any flues stopped up. This work should be done previous to boilermakers entering the fire box in order that they may check the work to see that it has been properly performed.

The brick arch, which has gained such a prominent part in the economical operation of the locomotive, should receive a great deal of care and consideration. By doing so the trouble experienced by leaky flues is very materially decreased and their life greatly increased. Care should be taken to see that the brick arch is properly cleaned after each trip and is maintained in perfect condition, and the engine should not be allowed to go into service with holes in the arch or with part of the arch missing as trouble is likely to be experienced either with the flues leaking or a poor steaming engine.

In the case of flues showing cinder-pit leak, they should be caulked by hand with standard beading tool. Flues blowing or leaking enough to allow water to run down the sheet should be expanded with a straight sectional expander; the use of the roller expander is not advisable. The leaks should be stopped with the sectional expander while the boiler is still comparatively hot, and a section of flues in the lower part of the sheet should be headed with a light air hammer and the standard beading tool after the boiler is empty. The flues should be inspected after the boiler is refilled and any leaks tightened up. This is especially important, because the inequalities in temperature occasioned by the cooling and washing have a tendency to break the joint of the flues in the flue sheet.

Coming to the washing of the boiler, the subject is so extensive and the methods used may be conducive to good or bad results that a few concise rules should be established as a proper method of preparing and washing the boiler. General rules stating that locomotive boilers are required to be washed out as often as may be necessary to keep them clean and free from scale and sediment is hardly sufficiently explicit, as individual judgments differ in this as on all other subjects, and observations gathered from various sources have shown that it is good practice that boilers should be thoroughly cooled before being washed, excepting where improved hot water washing systems have been installed. In most division points where there is no specially perfected appliances in use the injector is very serviceable in helping to cool the boiler. If there is sufficient steam pressure to work the injector it should be kept in operation until the steam pressure will no longer operate the injector. Then connect water hose to feed pipe and fill the boiler, allowing the remaining steam pressure to blow through syphon cock or some other outlet at the top of the boiler. The blow-off cock may then be opened and the water in the boiler allowed to escape, but not faster than it is forced in through the check, so as to keep the boiler completely filled until the temperature of the steel in the firebox is reduced to about ninety degrees, then all blow-off cocks may be opened and the boiler emptied as speedily as possible.

All wash-out plugs should then be removed, including arch tube plugs, and the washing of the boiler should begin with the crown sheet, starting on the sides and the washing through the holes in the back head. The door ring may then follow in the process, succeeded by a careful and thorough washing of the



TOOL FOR SCRAPING SHELL.

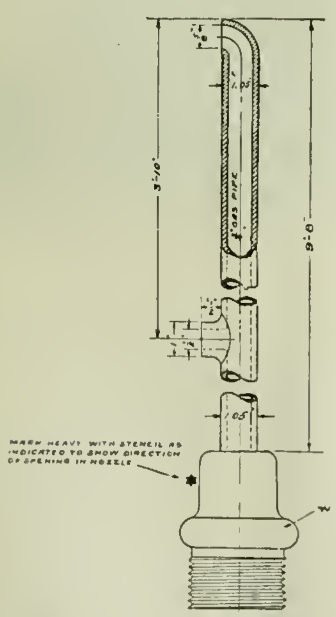
arch tubes, and it should be remembered that the pneumatic or other cleaner should be used every time that the boiler is washed out. The washing may then be continued through the plug holes in the barrel of the boiler immediately ahead of

the firebox, using a bent nozzle in order to thoroughly wash down the flues. The same appliance and method should be continued at the front of the barrel. In washing belly of the boiler, it is good practice to begin at the front end, using bent nozzle and washing scale toward the firebox.

In washing legs of boiler through plug holes in the side and corner of firebox, a straight nozzle should be used in corner holes and bent nozzle through side holes, revolving the same to thoroughly clean the side sheets. Rods should be used to dislodge any accumulation of matter that water pressure fails to remove.

When the operation is finished the boiler should be thoroughly inspected through the plug holes before any plugs are replaced. This inspection should be made by the foreman boilermaker, or special inspector, just as any other piece of work is examined by other than the workman himself. In returning the plugs in position it is good practice to apply a coating of graphite and oil made to the consistency of a paste. It will be found that if this practice is adopted the plugs may be removed at any time more readily. The water pressure should not be less than 100 pounds.

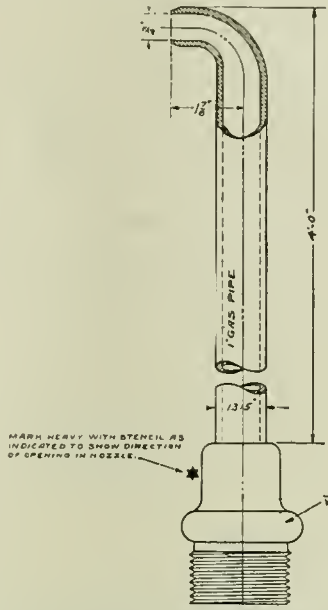
It must be remembered by those in charge that, when orders are issued to boiler washers to slight the washing of any boiler in order to get the locomotive ready for a certain run, they are storing up trouble for the future. Although it might not be in evidence at that time,



CROWN SHEET-WASHING NOZZLE.

the day of reckoning is sure to come. Blowing-out can be resorted to in some instances to save washouts, with either incrusting or alkali water, but care must be taken to see that the fire is in proper condition, that is, clean and bright.

The prevention of engine failures due to leaky flues does not rest entirely with the roundhouse boilermakers, regardless of the fact that they are compelled to assume the responsibility in most instances. One may take a locomotive with practically a new set of flues, and by the



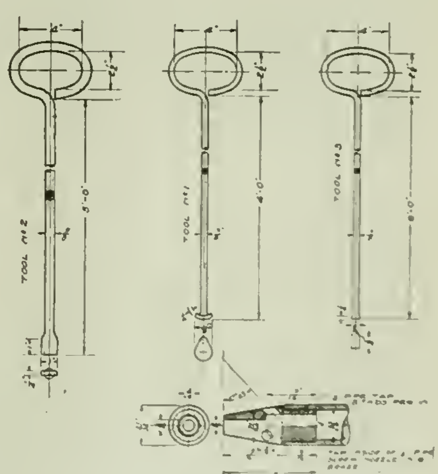
DOVE SHEET-WASHING NOZZLE.

improper use of the injector, cause most of the flues to leak. This can be demonstrated by getting into the fire-box after the fire has been drawn and the locomotive placed in the roundhouse with a perfectly dry set of flues, then start either the right or left injector and watch the results caused by the change in temperature of the water around the flues. The engineer and fireman should carefully examine the firebox sheets and flues as soon as they take charge of the locomotive, reporting any leaks or defects to the roundhouse foreman.

If the flues are all open, in good condition, and there is no mud on the flue-sheet, there is absolutely no reason for a failure due to flues leaking, yet there are cases where tonnage is reduced or trains set out, and on making an inspection of the flues, they are found to be in good condition, but loose in the sheet, which is prima facie evidence of the improper use of the injector.

After the cause and effect of the inequalities of temperature in the boiler is thoroughly understood by the enginemen and hostlers, it should not be difficult for them to fully appreciate the damage done to the flues and firebox sheets by the injection of water at a temperature of about 200 degrees lower than the water in the boiler. It is a common practice to fill the boiled at terminals while the blower is on and the fire door standing open, in order to eliminate the black smoke. Whenever it becomes necessary to fill the boilers while standing at stations or on sidings, a bright fire should be maintained, using the blower and applying fresh coal if necessary. The fire door should be closed while the injector is working. It is not desirable to put a large amount of water in the boiler at one time, unless it is necessary in order to protect the crown sheet. Enginemen should endeavor to leave their locomotives at the cinder pit with a full boiler of water and a good fire in order that the hostlers will not be required to fill the boiler just previous to blowing off. Care should be exercised by the hostlers in blowing off and in no instance should the boiler be blown off when the fire is dirty, and too much water should not be blown out at one time, in no case should the water be reduced over one gauge. Hostlers should see that there is plenty of water in the boiler to allow for re-firing, before knocking the fire, as it is very poor policy to put water into the boiler while cleaning or knocking the fire. Care should also be taken to see that the fire is clean and in good condition in locomotives that it is necessary to herd on account of short lay-over or shortage of round-house room.

The successful maintenance of the locomotive boiler in service is summed up in just one word, "Co-operation:" first, by the foreman and mechanics turning out a perfectly tight boiler from the locomotive works or the company shop. Second, the careful inspection and work of the round-house organization in keeping boiler tight and free from mud and scale. Third, in the careful handling by the enginemen. The best care and work-



TOOLS FOR CLEANING LARGE SUPERHEATER TUBES.

manship will be of no avail, however, if the boiler does not receive intelligent treatment while in service and limiting the time occupied in washing the boiler to a certain fixed period should be avoided if at all possible.

Test of the Automatic Straight Air Brake on the Virginian Railway

A test of the Automatic Straight Air Brake has recently been conducted on the Virginian Railway. It is said to be the most elaborate and thorough test that has ever been made on any railroad with any brake since the famous Galton-Westinghouse investigation in England in 1878. Certain fundamental principles of frictional resistance then discovered have set the pace in brake applications ever since. These recent tests on the Virginian Railway have shown that the possibilities of the air brake for rapidity and reliability of action have set up a new standard for the measurement of the efficiency and operation of brakes.

Our readers will recollect that in our issue of November, 1917, we published an account of certain tests that had been made with the Automatic Straight Air Brake, before a large group of railway officials, on a 100-car rack in New York. Last spring this same rack was turned over to the engineers of the Department of Safety of the Interstate Commerce Commission, who conducted an elaborate series of tests with the brake, the report of which has not yet been issued. At the conclusion of these tests the rack was dismantled and the equipment transferred to 100 hopper-bottom coal cars on the Virginian Railway. When this had been done, the Safety Department of the Interstate Commerce Commission again took charge and conducted the elaborate investigation which is the subject of this review. The thoroughness with which the work was done, may be indicated by a brief resumé of the equipment in the form of measuring apparatus that was used on the train, merely stating that this equipment was designed for work both on a standing and a running train.

The engine was fitted with an Oliver-Boyer speed recorder for the information of the engineman. There were also two "Toolometers" or air-flow recorders, by which, in certain tests, the amount of air delivered to the brake system, back of the locomotive was measured. The handle of the engineer's brakevalve was fitted with an electrical contact device by which a contact was made at each of the five cardinal points of operation, to wit: the emergency, service, lap, running, and full release positions.

Wires were carried back from each of these positions to electrically controlled pens on a "Chronograph" apparatus located in the caboose. There was also a telephone wire running from the engine to the caboose with several cut-in stations so that observers along the train could be kept in communication with those in control in the cab and the caboose.

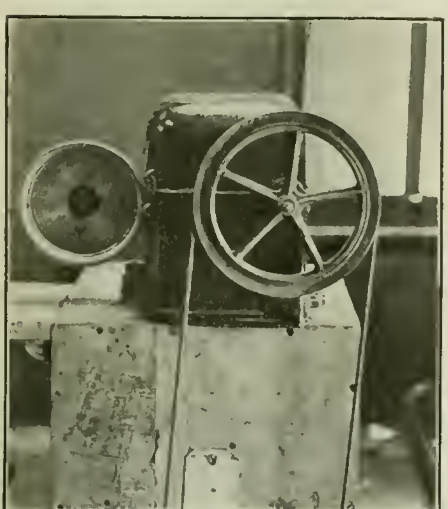
To the locomotive and to each car of the train there was attached a "Trainograph." This instrument consists of a clockwork mechanism, driving a continuous strip of paper on which was recorded the brake cylinder pressure, and also that of the train-pipe and auxiliary reservoir, existing on the car to which it was attached. This made it possible to compare the action of the brakes throughout the whole length of the train. Pressure gauges were also attached to the first, middle and last cars of the train that were arranged to break an electric circuit whenever the brakes were applied, and make connection when they were released. Wires from these were also led to the "Chronograph" in the caboose with its electrically controlled pens, by which the application and release of the brakes on the first, middle and last cars, were recorded.

A grooved pulley was placed on one of the axles of the caboose from which a spring belt drove a reducing contact gear, by which an electric circuit was closed at each sixty-fourth revolution of the wheels. The wires from this were led to one of the electrically controlled pens of the "Chronograph," so that an indication was made at the end of each train advance of about 570 ft. A clock making and breaking a circuit every ten seconds, was connected in the same way. The "Chronograph," in the caboose, as shown in our engraving, consisted of a recording apparatus, using a continuous strip of paper driven by an electric motor at a speed of 18¾ ins. each minute. It carried eight pens, seven of which were recording; and, as two of these had a double motion, the apparatus was capable of making nine records. One of these records showing a brake application and release is shown in another of our engravings. The paper was moved from right to left so that the records were drawn from left to right.

The top line (A) was drawn by the extra pen and serves only as a base, the pen being held in reserve to be put in the place of any pen that became exhausted. Line (B) gave application and release indications for the middle car of the train. Line (C) gave the same indications for the last car and (D) for the first car. It so happened that the record here reproduced, was taken on a 50-car train.

TEST TRAIN ON THE VIRGINIAN RAILWAY, 104 CARS LONG—100 FREIGHT AND 4 CABOOSES.

Line (E) indicated the periods when the engineer's brake valve was in running or full release position. Line (F) marks each 10 seconds intervals of time. Line (G) marks the passage of each 570 ft. of run, and, in addition thereto, an observer



OLIVER-BOYER SPEED RECORDER.

in the monitor of the caboose recorded the passage of each mile post and station. Line (H) indicated the periods of service application and lap position of the engineer's brake valve. This was for the running tests. For the standing tests, line (G) was used to mark the emergency position of the brake valve. It is evident from the record of the elapsed time for the passage of any 570 ft. interval a calculation of the average speed of passing that distance can be made.

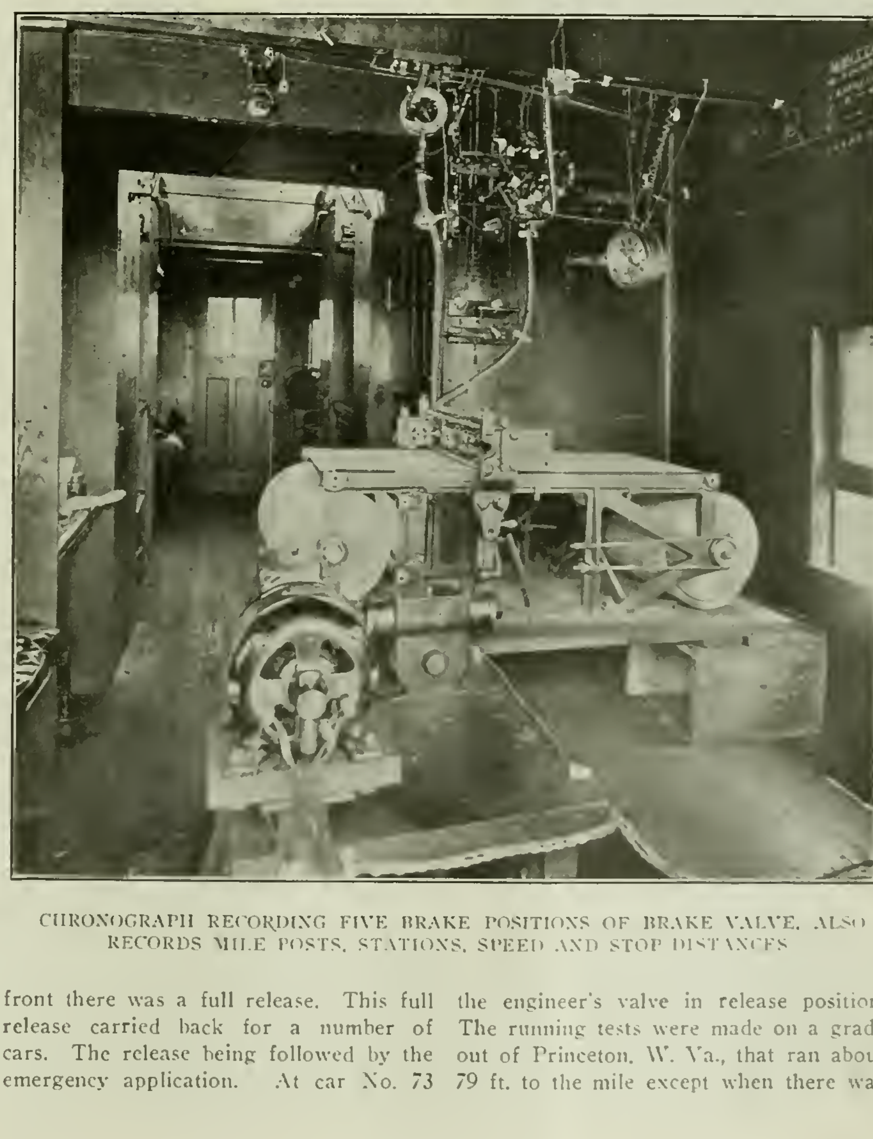
Referring to the engraving of the record of the brake while in running position, and first put into service at (a) then into lap at (b); then in release at (c) and finally back into running, at (d). The brakes applied on car 1, at (e); on car 26 at (f) on car 50 at (g). The release on car 1 occurred at (h); on car 26 at (i); and on car 50 at (k). The serial action between the first and last car for both application and release was about 10 seconds.

Finally one of the rear wheels of the train was fitted with thermo-couples in the rim, plate and hub, by means of which the temperature of the wheel was obtained while in motion and subjected to brakeshoe pressure. A similar couple was also put in the corresponding brakeshoe. It will be seen that this apparatus removes any possibility of the "personal equation" of any observer having any effects on the results. It will be remembered that, in our previous article regarding the rack tests of last fall, especial emphasis was placed on the high rate of transmission of the serial action of the brakes. This same condition prevailed on the road tests.

It will be impossible to enter into the details of all the tests that were made but some things were accomplished that were unusual, and they will probably be particularly interesting to our readers. One of the things that is desirable, but has not been obtained heretofore, is the full emergency application of the brakes immediately after a service application. Tests were made that established the possibility of obtaining such an action with the Automatic Straight Air Brake. For example, on a 50-car train, the brake was put into service position for 5½ seconds, ending with an emergency application for 20 seconds. The brakes were fully applied in 14 seconds after the first movement of the brake valve, with a serial action on the fifty cars of 8¼ seconds, then came a full emergency application. This was repeated often enough to demonstrate the reliability of the action.

Again with a 100-car train a 10-lbs. reduction was made in the brake pipe followed by an emergency and full release both of which were obtained. One of the most striking exhibitions in the standing test was that of a full service application, followed by going to full release for 10 seconds and then immediately to emergency. The trainograph records show that there was a service application on every car of the train, and that at the front there was a full release. This full release carried back for a number of cars. The release being followed by the emergency application. At car No. 73 the emergency overtook the service, the pressure having just started to fall when the emergency interrupted and sent the brake into that application. From car No. 74 to car No. 100 there was no sign of any influence of the release and the record showed merely a service application followed by a full emergency. It was as though the engineman had made a service application, followed by a release when he was suddenly confronted by the necessity of going to emergency. The release was coursing back through the train, when he sent the emergency chasing it, and the latter being the more rapid runner of the two, overtook it at the seventy-third car and, putting a stop to its career, assumed full control of the train, and then by the rapidity of its action would have brought the train to a standstill.

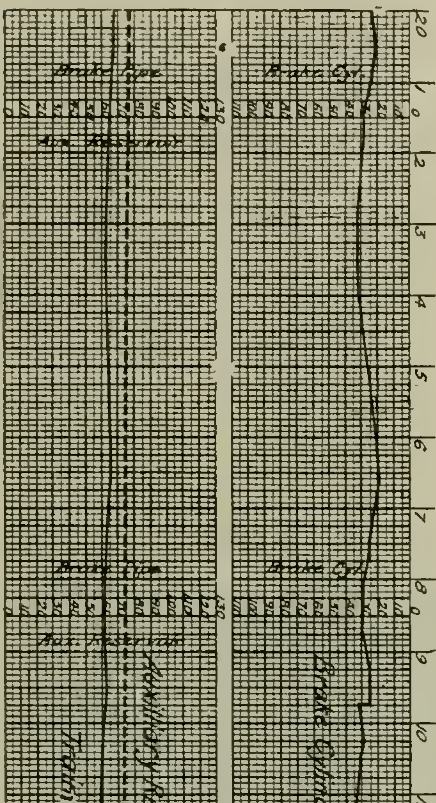
The angle cock back of the caboose on a hundred car train was opened while the engineer's valve was in running position, and the emergency sent ahead to the front car against the inflow of air. This had been previously paralleled on the rack, where an emergency application had been sent through the whole 100-car equipment against the inflow of air with



CHRONOGRAPH RECORDING FIVE BRAKE POSITIONS OF BRAKE VALVE. ALSO RECORDS MILE POSTS, STATIONS, SPEED AND STOP DISTANCES

the engineer's valve in release position. The running tests were made on a grade out of Princeton, W. Va., that ran about 79 ft. to the mile except when there was

a compensation for curves. The length of the grade was about eleven miles, and trains of 50, 75 and 100 cars were taken down it. Although the observers were fully convinced of what would happen in the case of an emergency application with the train in motion, there was no intention of making such an application during any



TRAINOGRAPH RECORD.

of the running tests; but the equipment, as though conscious of its own possibilities took matters into its own hands, so to speak, and while the train was running down the steepest portion of the grade at a speed of 11.9 miles an hour, a hose blew off from its nipple about six cars ahead of the caboose. Emergency application followed on every car of the train and that so quickly that there was no run-in at the rear or jerk at the front. No shock was felt on the engine. The whole train was brought to a standstill evenly and smoothly. Then, as if to emphasize the fact that this was but an ordinary performance, a couple of knuckles slipped by each other, about ten cars from the rear, just after the train had started again, with the same result. In short, the emergency application was so rapid, in its action, that no bump or shock resulted from it.

It is a recognized principle of current practice that, in using the cycling action of the brakes on descending grades, the release must follow the application before the speed of the train has been reduced below eight or ten miles an hour; else there will be a run-out and shock that is pretty apt to cause a break-in-two. On one trip down the grade with a fifty-car train of A. S. A. brakes, an application was made and held on. The speed was reduced until an average for 570 ft. of 4.4 miles per hour was recorded on the "Chronograph" and a minimum of 2¾ miles an hour on the Boyer speed recorder. That the actual minimum speed must have been about that, is shown by this: Mr. M. E. Hamilton, assistant to the superintendent of motive power and the air brake expert of the Frisco Lines, got down from the engine cab and walked ahead, feeling the crank pins and climbed up on the pilot of the engine. At the same time, Mr. H. B. MacFarland, Engineer of Tests of the Atchison, Topeka & Santa Fé, stepped down from the rear caboose and walked forward to the "Chronograph" car. This showed that the speed indicated by the Boyer recorder of 2¾ miles an hour was, so to speak, "checked up" by the performance of these men. At this low speed, and while running down a grade of 80 ft. to the mile the brakes were released, and so rapidly was this effected that no shock was felt upon the engine or in the caboose. The whole performance depended upon certainty and rapidity of action. The fact that all brakes on the train were applied very nearly simultaneously, means that the retarding action throughout the whole length of the train was practically the same. Hence there was no tendency for cars to run away from or into each other.

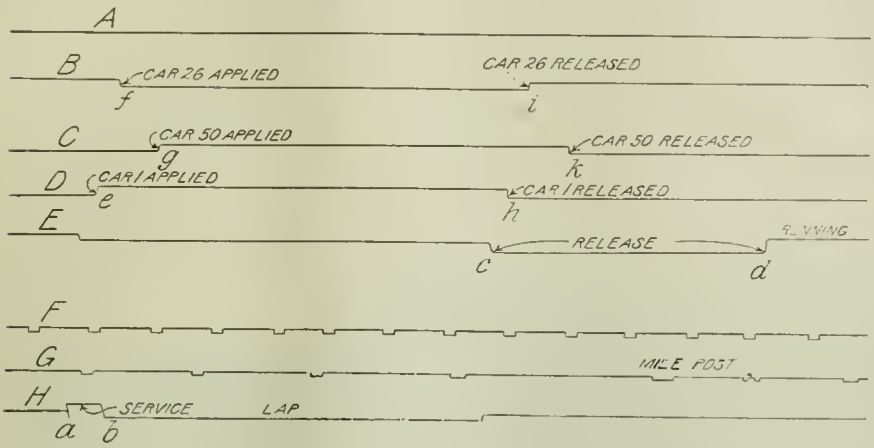
On one occasion a fifty-car train was taken down about six miles of this hill, from Ingleside to Kelleysville, at a speed so nearly constant that the maximum was 15.9 and the minimum 10.4 miles an hour. This was accomplished because of the possibility of making a brake application and, by the means of the graduated release, holding that application while at the same time raising and lowering the brake cylinder pressure so as to meet the requirements of the control. To show how delicately this can be adjusted, a trainograph record is reproduced. This record covers a run of twenty minutes, down the 80-ft. grade, and was taken on the one-hundredth car. It will be seen that, for these twenty minutes, the pressure was raised and lowered between the extreme limits of 17 and 37 lbs. per sq. in., in the brake cylinder, with four waves or crests of pressure in the same twenty minutes. That means control of the train at all times. It also means relief for the engineman from all anxiety as to the operations of his brakes, and a lowering of the stresses on the foundation brake rigging because of the lower speeds and the lower brake cylinder pressures involved in letting a train down a long, steep grade. One of the most important results con-

CONTACT, RECORDING PREDETERMINED EQUAL DISTANCES.

sequent upon this is the lowering of wheel temperature on long grades. It is evident that the temperature would be less under uniform speeds and brake pressures than where there are wide fluctuations in both.

The usual method of negotiating this Kelleysville hill on the Virginian Railway, is to turn up the retainers; use the brakes in a cycling operation and stop at Ingleside, half way down, to examine the wheels to make sure that none were overheated. It was because of this that the measurement of the temperature of one of the wheels was undertaken, and that for the first time in the history of railroading. The results exceeded all anticipations. On run after run these meas-

urements were made. There would be a rise of brake shoe temperature with each application, followed by a fall in temperature at each release. The couple in the rim of the wheel would show it gradually rising in temperature during the application of the brakes and then, like the shoe, a falling off on release. But the rise did not increase indefinitely. The



SHORT SECTION OF CHRONOGRAPH RECORD.

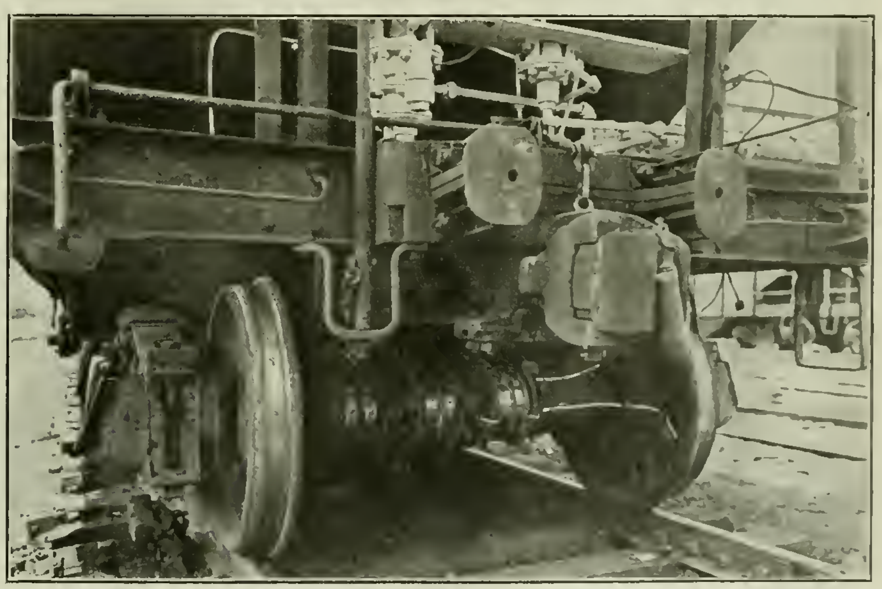
rim heat would climb slowly and then, when the train was under control and running slowly the radiation would be rapid enough to compensate for the heat generated and there would be no further rise. On one occasion, as the train was moving slowly into the Kelleysville yard with the brakes applied, the radiation was so much more rapid than the generation of heat, that the rim temperature dropped 20 degs. F. during this period of slow running.

It is a common occurrence with which all railroad men are familiar to find wheels smoking hot at the foot of a long grade. In the tests on the Virginian Railway the average temperature of the rim, on reaching the foot of the grade, was in the neighborhood of from 180 to 200 degs. F., with a maximum recorded temperature on the grade of 240 degs. F. The plate below the rim, rarely showed any rise of temperature and never above 160 degs. F., while no rise at all was recorded at the hub. The brake shoe of course got hot even at that, the maximum recorded temperature was only 670 degs. F. This means, so far as the destructive heat stresses in a wheel are concerned, they can be entirely eliminated, on such a grade as that by such brake manipulation.

As evidence of the impression made by this experiment on the railway officials present, permission was given to cut out the half-way, or Ingleside stop, on the run down the hill with the 100-car train. This was done and, upon arrival at Kelleysville, after a 12-mile run down an 80-ft. grade, the temperature of the brakeshoe was 340 degs. F. and the rim of the wheel showed 200 degs. F. The plate gave a temperature of 100 degs. F., with no apparent rise of the hub.

Of course all this must be accomplished in harmony with and without interfering with the action of the present brakes. And this has been accomplished. Trains were run with every conceivable mixture of Westinghouse and A. S. A. equipment. There were 50 cars at the front and 50 cars at the rear of one kind or the other. There were trains made up of blocks of five each of one kind, and five of the other; and of scattered units of one mixed in with larger numbers of the other. In no case was there any failure to synchronize and work properly together.

The air brake is recognized as a most important element in train operation and any improvement in its operation must make for increased safety and efficiency. In this device we have one that can be



WHEEL TEMPERATURE COMMUTATOR ON THE HUNDREDTH CAR.

made to hold brakes on indefinitely, the only limitation being the capacity of the air pumps to supply the leakage from the brake, cylinders and the train pipe. In no service application is there any draft put upon the auxiliary reservoir, that is held fully charged, ready at all times for the use of making an emergency application. The speed of serial action is so great in both application and release that shock is eliminated and break-in-twos reduced to a minimum. Emergency can follow on the heels of service or release without danger, and a release after an emergency is possible. All of these new functions of the A. S. A. brake which bring to train control so many added features are accomplished with a smaller consumption of compressed air than that required with ordinary present day service. In short, what has previously looked like the unattainable, has thrust itself forward into the realm of practical railroading.

The Blacksmith.

The blacksmith of today represents the artisan of ancient times who originated and developed the art of metal working.

The smith has been a mighty man in the world's history. He not only handled tools, but made them for all other craftsmen. To properly appreciate the valuable services performed to mankind by the blacksmith, it is necessary to understand the important part which iron has accomplished in civilizing the world. Without iron or some metal capable of being made into tools, man would never have risen above the condition held by Red Indians when America was discovered. It was clearly man's destiny to use tools, for without their aid he was more helpless than the beasts of the field, for nature has provided him with no natural weapons and he lacks the fleetness that enables other animals to escape from those that seek their destruction.

Up to quite recent times nearly all the progress made in metal working was in connection with warlike purposes. Steel makes a much better ax than bronze or iron, but it is doubtful if the art of steel making would have been developed had the metal not made a matchless sword.

New Pacific and Mikado Type Locomotives for the Chicago, Burlington & Quincy Railroad

During the past few years, four classes of locomotives for road service have been built by The Baldwin Locomotive Works for the Burlington System. These classes are as follows:

(1) A Pacific or 4-6-2 type for passenger service, with 27 x 28 ins. cylinders and 74 ins. driving wheels, first built in 1915.

(2) A medium-weight 2-8-2 Mikado, with 27 x 30 ins. cylinders and 64 ins. driving wheels, first built in 1911.

(3) A heavy Mikado, 2-8-2 28 x 32 ins. cylinders and 64 ins. driving wheels, first built in 1912.

(4) A Santa Fe, sometimes called a mountain or 2-10-7 type, with 30 x 32 ins. cylinders and 60 ins. driving wheels, first built in 1912.

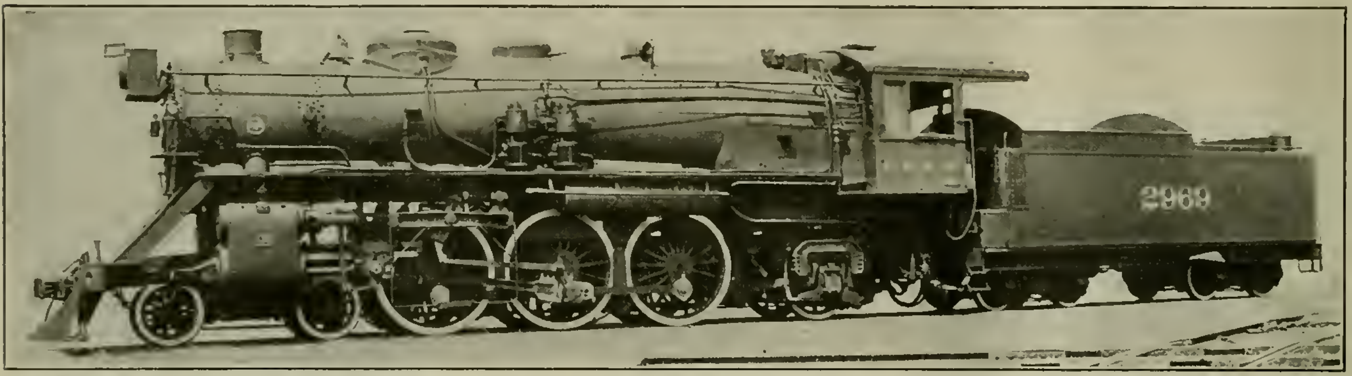
A careful study has been made of these four classes, with a view to improving many and various details when placing successive orders while the leading dimensions of each class have been retained, and no change has been made in the tractive force developed, the designs have been thoroughly revised since the first locomotives were built. At present an order which includes all four classes is being completed.

Special interest centers in the Pacifics and the medium-weight Mikados, because of the extent to which interchangeable parts are introduced into these designs. A large number of details and fittings are interchangeable in all the locomotives, but the dimensions of the two types referred to are such that this policy can be carried out to an unusual and satisfactory degree.

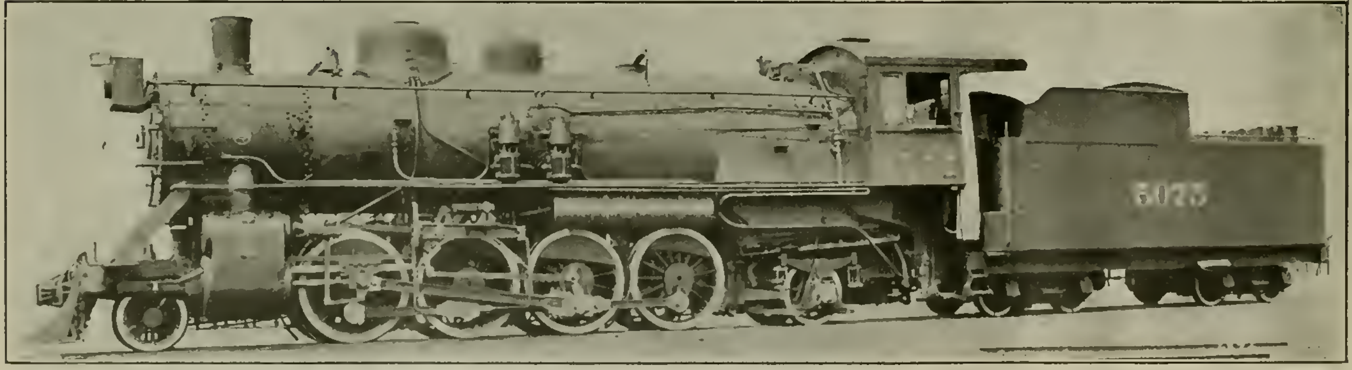
The Pacific type exerts a tractive force of 42,200 lbs., and the Mikado of 52,200 lbs.; the ratio of adhesion being slightly over 4 in each case. The boilers are alike, except for a few changes in details incident to the different classes of service for which the locomotives are intended. The barrel is built with three rings; the first ring is sloped on the top, and the third ring on the bottom. This provides a large steam space, and an easy entry to the firebox throat. The main dome is placed on the middle ring. Here the longitudinal seam is on the right-hand side, and a large inside liner covers the seam and re-enforces the shell under the dome opening. The auxiliary dome is on the third ring, and is placed over a 16-in. opening in the shell. The seam, which is on the top center, is welded thoroughout its length, and re-enforced by inside and outside welt strips. By removing the auxiliary dome the boiler can be entered without dismantling the throttle rigging.

The firebox has a combustion chamber, and the seams uniting this chamber with the crown and throat, and those uniting the throat and side sheets are welded. A brick arch is installed, and is supported on angle irons studded to the side sheets. The grate rocking bars are held in rectangular frames, which are trunnioned so that they can be tilted through a wide angle when dumping the fire. The grate castings interchange on the two types of locomotives. The ash-pans of both types are of the double-hopper pattern with swing bottoms, and separate the operating rigging for each hopper.

The cylinders of the Pacific and medium-weight Mikado type locomotives are cast from the same pattern. The steam chest heads are interchangeable, and the cylinder heads are similar, except that those of the Pacifics are recessed to a greater extent than those of the Mikados, to allow for 2 ins. less piston stroke. There is a slight difference in the steam-chest bushings, the ports being so cut that



PASSENGER PACIFIC OR 4-6-2 TYPE OF LOCOMOTIVE FOR THE C. B. & Q.
J. W. Cyr, Supt. Motive Power — Baldwin Locomotive Works Builders



MEDIUM WEIGHT MIKADO OR 2-8-2 LOCOMOTIVE FOR THE C. B. & Q.
J. W. Cyr, Supt. Motive Power — Baldwin Locomotive Works Builders

on the passenger locomotives there is an exhaust clearance of 1/8 in., while the valves are line-and-line on the freight engines. No by-pass valves are used on these cylinders, but vacuum relief valves are tapped into the steam chests. The piston-valves are interchangeable, as are also the pistons and their rods, except for a slight difference in the length of the latter. The piston heads are rolled steel, of light section, fitted with cast iron bull-rings which are shrunk on, and further secured by electrically welded retaining rings. The piston rods are extended, and are of Nichrome steel, hollow bored. Interchangeable crossheads are used on these two types of locomotives. They are of the Laird pattern, with light bodies of .40 carbon steel with bronze shoes. The crosshead wrist pins are of Nichrome steel hollow bored, and the same is true of all the crank-pins on the Pacific type, and the main pins on the Mikados. Nichrome steel is also used for the main and side rods, and for the stub straps of both types; and the main rod stubs are alike on the two locomotives. All the driving axles are of chrome vanadium steel, hollow bored.

A light design of Walschaerts valve gear, with Ragonnet power reverse mechanism is used on these locomotives. The valve gear pin bearings are fitted with case-hardened bushings. The power reverse cylinder, in each type, is placed immediately back of the reverse shaft, so that a short reach-rod connection can be used.

The design of the machinery, as above described, is the result of careful study on the part of the railroad company and the builders; and by the use of special materials and correct proportions the parts have been lightened and the dynamic augment on the rail materially reduced. Tests have shown a marked reduction in bridge stresses as a result of this policy. Light parts are also used on the heavy Mikado and Santa Fe type locomotives.

The main frames of the Pacific and medium-weight Mikado type locomotives are 5 ins. wide, of .40 carbon steel annealed. The driving-boxes interchange on these two types, as do also the pedestal wedges. The shoes and wedges are of bronze. The Rushton design of trailing truck, with outside journals, is used on the passenger locomotives. In this instance the swing links are of the three-point suspension pattern. This acts as an effective stabilizer, and no centering device is necessary. The Mikados are equipped with the Hodges trailing truck.

The cabs have been redesigned, and they are considerably shorter than those used on the previous locomotives. This saves unnecessary weight and gives the enginemen a better view through the front cab windows. The steam turret is placed outside the cab, and the valves have extension handles. Each locomotive is equipped with a speed recorder which is driven from the rear truck axle.

The tenders of both types are similar in construction, and are equipped with coal pushers. The frames have 12-in. channels for the longitudinal sills, with oak front bumpers and back bumpers of built-up steel. Equalized pedestal trucks are used with the Pacific type locomotives, and arch-bar trucks with the Mikados. The wheels, in each case, are of forged and rolled steel. The tables appended show the principal dimensions of these locomotives.

Pacific or 4-6-2 type:

Cylinders, 27 x 28 ins.; valves, piston, 14 ins. diameter. Boiler—Type, wagon-top; diameter, 78 ins.; thickness of sheets, 3/4 and 13/16 in.; working pressure, 180 lbs.; fuel, soft coal; staying, radial. Fire Box—Material, steel; length, 108 1/8 ins.; width, 78 1/4 ins.; depth, front, 85 3/4 ins.; depth, back, 72 ins.; thickness of sheets, sides, back and crown, 3/8 in.; tube, 5/8 in. Water Space—Front, 6 ins.; sides 6 to 4 ins.; back, 4 ins. Tubes—Diameter, 5 1/2 and 2 1/4 ins.; material, steel, 5 1/2 ins.; iron, 2 1/4 ins.; thickness, 5 1/2 ins., No. 9 W. G.; 2 1/4 ins., No. 11 W. G.; number, 34, 5 1/2 ins.; 200, 2 1/4 ins.; length, 18 ft. 6 ins. Heating Surface—Fire box, 233 sq. ft.; combustion chamber, 59 sq. ft.; tubes, 3,072 sq. ft.; total, 3,364 sq. ft.; superheater, 751 sq. ft.; grate area, 58.7 sq. ft. Driving Wheels—Diameter, outside, 74 ins.; center, 66 ins.; journals, main, 11 x 12 ins.; others, 10 x 12 ins. Engine Truck Wheels—Diameter, front, 37 1/4 ins.; journals, 6 x 12 ins.; diameter, back, 48 1/4 ins.; journals, 8 x 14 ins. Wheel Base—Driving, 13 ft.; rigid, 13 ft.; total engine, 33 ft. 8 1/2 ins.; total engine and tender, 68 ft. 4 ins. Weight—On driving wheels, 171,300 lbs.; on truck, front, 49,300 lbs.; on truck, back, 48,600 lbs.; total engine, 269,200 lbs.; total engine and tender, about 433,000 lbs. Tender—Wheels, number, 8; diameter. 36 ins.; journals, 5 1/2 x 10 ins.; tank capacity, 8,200 U. S. gals.; fuel, 13 tons; service, passenger.

Mikado or 2-8-2 type:

Cylinders, 27 x 30 ins.; valves, piston, 14 ins. diameter. Boiler—Type, wagon-top; diameter, 78 ins.; thickness of sheets, 3/4 and 13/16 in.; working pressure, 180 lbs.; fuel, soft coal; staying, radial. Fire Box—Material, steel; length, 108 1/8 ins.; width, 78 1/4 ins.; depth, front, 85 3/4 ins.; depth, back, 72 ins.; thickness of sheets, sides, back and crown, 3/8 in.; tube, 5/8 in. Water Space—Front, 6 ins.; sides, 6 to 4 ins.; back, 4 ins. Tubes— diameter, 5 1/2 and 2 1/4 ins.; material, steel, 5 1/2 ins.; iron, 2 1/4 ins.; thickness, 5 1/2 ins., No. 9 W. G.; 2 1/4 ins., No. 11 W. G.; number, 34, 5 1/2 ins.; 200, 2 1/4 ins.; length, 18 ft. 6 ins. Heating Surface—Fire box, 233 sq. ft.; combustion chamber, 59 sq ft.; tubes, 3,072 sq. ft.; total, 3,364 sq. ft.; superheater, 751 sq. ft.; grate area, 58.7 sq. ft. Driving Wheels—Diameter, outside, 64 ins.; center, 56 ins.; journals, main, 11 x 12 ins.; others, 10 x 12 ins.. Engine Truck Wheels—Diameter, front, 37 1/4 ins.; journals, 6 x 10 ins.; diameter, back, 42 1/2 ins.; journals, 8 x 14 ins. Wheel Base—Driving, 16 ft. 9 ins.; rigid, 16 ft. 9 ins.; total engine, 33 ft. 9 1/2 ins.; total engine and tender, 68 ft. 5 ins. Weight—On driving wheels, 211,300 lbs.; on truck, front, 27,900 lbs.; on truck, back, 39,400 lbs.; total engine, 278,600 lbs.; total engine and tender, about 472,000 lbs. Tender—Wheels, number, 8; diameter, 33 ins.; journals, 6 x 11 ins.; tank capacity, 10,000 U. S. gals.; fuel, 19 tons; service, freight.

The Trans-Australian Railway.

Mail advices from Australia recently told of the completion of this railway—but another example of British colonial development—from Kalgoorlie (in the State of Western Australia) to the eastern terminus at Port Augusta (in the State of South Australia), a distance of 1,053 miles.

In 1911 the Commonwealth Parliament passed a bill for the construction of the Kalgoorlie-Port Augusta railway under the supervision of the Railway Department, and the work was begun next year, the first sod being turned by the then Governor-General, Lord Denman, on September 14.

The construction of the line has been an undertaking of great magnitude. Along the whole route there is no surface water, and for 800 miles no habitation whatever. In crossing Nullabor Plain the line runs 330 miles without a curve.

Operations were commenced from either end, and two Roberts tracklayers purchased in the United States employed. The rails are 80 lbs. to the yard; ties of Australian timber, and ballast of broken stone and gravel.

While there were no rushing torrents to bridge or mountains to pierce by tunnels, the absence of water caused manifold hardships. There is not a single tunnel on the entire 1,053 miles.

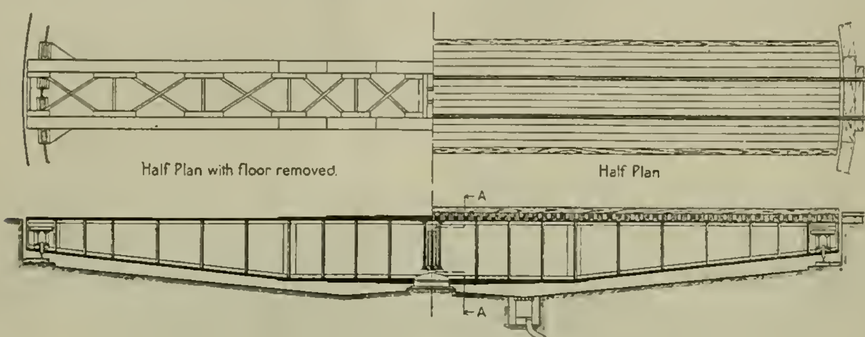
The railway is designed for high-speed traffic. When ballasted throughout it will be possible to make a speed of 44 miles per hour, comparing favorably with other express train services in Australia.

Before the new great highway was flung across the continent the only link between east and west was the telegraph along the coast of the Great Australian Bight. To make the journey meant a sea voyage of over 1,000 miles.

It is interesting to compare this great work of development in Australia, with the comparatively insignificant work that has been accomplished in the same direction by the German government while it was in possession of vast areas in Africa, and where the country gives promise of a much higher degree of development than certain areas in Australia.

Construction, Care and Maintenance of Turntables

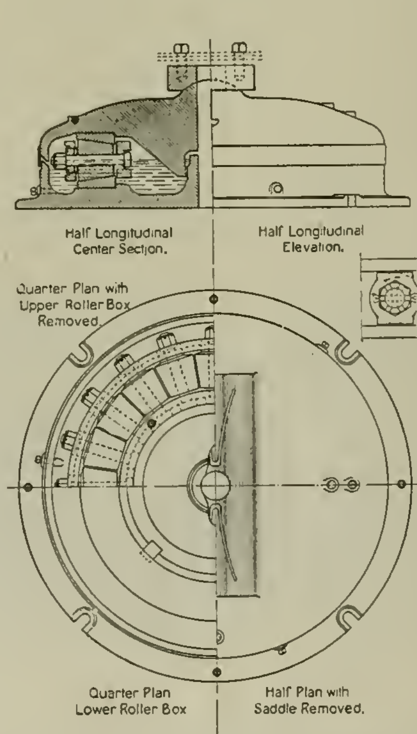
The new types of turntables are marked by many improvements, necessitated by the rapid and radical changes in the past few years in the type and design of locomotives. The older designs were but temporary expedients rather than definite application of engineering principles. A number of engineering firms now manufacture turntables intended to meet the requirements of long life, and at moderate costs. The dimensions now run from 50 ft. to 110 ft., varying by 5 ft. The end trucks have wheels of one diameter, but with two widths of face and two sizes ot journals. The centers are generally of three sizes adapted to the general weight of engines used.



SECTIONAL ELEVATION, DECK TURNTABLE.

The girders as shown in the main illustration are made deep at the center, and so constructed that they are stiff under loads, and the center cross girders are designed to deliver the weight of the engine and turntable to the roller center in the best manner. Cross frames are used at lateral panel points. Structural steel, as called for by the American Railway Engineering Association, is used for all girders and their bracing. The end wheels have treads of liberal width and the journals are unusually large in order for the dynamic effect of passing locomotive wheels, when the ends of the turntable are not kept in good adjustment. The centers are made of the cone roller type, and provide for good distribution of the loads to the masonry. They are easily maintained and reduce the turning friction to a minimum. The center longitudinal girders rest on a saddle which bears on a hump, of small radius, on the top of the upper roller box, so that if an engine stops with its center of gravity away from the center of rotation, the table tips on the hump and one set of end wheels is made to bear on the circle-rail, but the load on the center is still delivered centrally.

The roller cage, as shown in the second illustration consists of an inner ring, which takes all roller thrusts, and an outer ring which determines their correct spacing, and special provision is made for adjusting the rollers endwise. Fine threads are cut on the outer ends of the roller pins and castle nuts used so that accurate endwise adjustment of the rollers is made when the center is assembled in the shop. Good lubrication of all interior moving parts is assured by filling the lower roller box with oil up to the oil-lip overflow line, which is above the center of the rollers. A dust guard extends around the outside of the center covering the oil-lip joint so as to exclude dust and water. The upper and lower tread plates are specially treated steel castings with their cone bearing surfaces ground. The rollers are also made of special steel forgings with their cone surfaces and thrust ends ground.



DETAILS OF ROLLER BOX IN TURNTABLE.

Coming to the older types of turntables, a large number of which are still in use, it is a singular circumstance that some of the most important mechanical appliances used on railroads are the most neglected. Turntables belong to this category. As long as it is in good working order locomotives may be moved in and out of the engine house with ease. When something happens and it works hard, delays occur, and between the loss of time and the growth of the trouble, whatever it is, much needless expense is incurred. As a rule, nobody seems to take particular charge of the turntable, but it seems to us that the engine house foreman should observe its condition and report any defects to the proper authorities, whether it be the master mechanic or the resident engineer.

Taking the causes of trouble categorically, there is the center bearing, the elevation of tracks and clearances, the levels and incidental twists to the structure, the foundations and drainage, the material, deck, and, it may be added, the climatic conditions—snow and ice. The center bearing consists of a set of conical rollers or balls, supposed to be running in oil between two castings. The oil has generally passed away by the process of evaporation. If taken in time, and the table is jacked up, and the balls or rollers are taken out and thoroughly cleaned, and put back in fresh lubricant about twice a year, and good oil is added at reasonable intervals, the bearing will rarely need any further attention. A growing cause of trouble arises from the fact that in the older turntables the balls are rather too small to bear the weight of the modern heavy locomotive. Changes are being made gradually to the roller type, but not as rapidly as they might be, and closer attention should be given to the bearings and broken balls promptly renewed.

A common fault or weakness occurring in the older turntables is the improper adjustment or elevation of tracks. When a locomotive is on the table it will deflect about three-quarters of an inch at each end. The tracks leading to the turntable should all be at absolutely the same elevation all around the turntable pit. The table should then be high enough so that when balanced with load the rails on the table will be at least one inch above the rails on the pit walls at each end. This is of real importance, because this allowance of one inch or more of an elevation of the rail in the table will be all taken up when the locomotive is going on or coming off the table, and if the track rails are higher than those on the table, the tendency to damage the rails or even cause a derailment is very great.

As is well known, frost, such as we had last winter, will interfere with the most exactly adjusted turntable by heaving the pit walls. The rails on the

turntable should not be adjusted to meet this emergency because the heaving or moving of the foundation is, in the very nature of physical phenomena, irregular. And it is so easy to make matters worse.

The proper way is to jack up the turntable a few inches, blocking under one end, and jacking up the other, and put a steel shim on the center casting under the loading girder. Shimming up the turntable restores the lost clearance and leaves the table in correct adjustment. If heaving, or moving of the earth beneath, is unequal, the table should be shimmed high enough to clear the circle rail at its highest points. The timber on which the turntable rails rest should not be changed by reducing their size. It may be added that the pernicuous effects of extreme climatic conditions may be largely avoided by proper drainage, and an application of hot water at the psychological moment

It will have been observed by railroad men of experience that light turntables develop a twist or warp. It can be readily detected by noting the clearance under the end wheels as the locomotive is passing on or off. It is no hard matter to turn the empty turntable and note the variation in the clearance. If the center pier is exactly level, the difference in the clearance will be the amount of the twist. If the pier is not level the difference will be accentuated and easily discoverable. It will not take long to turn the turntable several times and discover the amount of twist, and also the amount and direction of shape, if any, to the pier. If it should be discovered that the pier is not level, the turntable should be lifted and also the pier, and the pier top should be levelled. The twist can be then corrected by putting shims between the end roller boxes and the steel girders to level all of the four corners and to make the rails level at both ends of the turntable. This may throw the deck out of level, and that can be corrected by facing the deck ties properly.

When these shims are once put in they must not be altered or removed except by proper authority, and that only when tests show that the amount of warp in the girders has altered.

The steel girders, floor system and bracing require frequent cleaning and painting. On too many of our tables the outside of the girders have been well painted and the less accessible parts inside allowed to become dirty and rusty. Whenever painting is done the cleaning and scraping of the steel must be especially thorough, on account of the large opportunity for the collection of wet dirt and refuse on the steel, and the many corners difficult to clean. Locomotive men can help on this point by not starting their injectors on the table, so as to avoid as far as possible dripping water on to the steelwork.

The deck of a turntable usually requires little or no care, except that when the end heights are not correct, the end ties get pounded to pieces quickly. A number of tables have a walk on the deck, consisting of one or two stout planks; some have the deck entirely covered with light boards. The latter is especially undesirable from a maintenance standpoint. When the deck is covered, the steel underneath is kept almost constantly wet and does not get a chance to dry out and inspection is rendered difficult. If any walk at all is on the table it should be away from the girders or stringers, so that the steel may be readily cleaned. However, the turntable is intended for use in turning locomotives and not as a footbridge across the pit, and if the area around the pit is kept clear and in shape, there is no necessity whatever for any one walking across the table except to get to the centre for inspection and repairs. Any plank walk is therefore unnecessary, as well as detrimental to the table.

In winter snow and ice collect in the pits and interfere with operation. The duty of cleaning out the pit devolves on the trackmen, but the locomotive house force should give them assistance at all times. Generally in winter, when a table is reported as working hard, the trouble, if not due to heaving of foundations, is found to be caused by an accumulation of ice around the centre. In severe weather this should be watched and ice cleared out as fast as it forms, instead of allowing it to collect until it becomes a nuisance.

Where tables are operated by air motors, the care of the motor and accessories devolves on the locomotive house staff. They should periodically examine and overhaul all parts of it. If they allow a tractor to get out of repair so that they have to turn locomotives by man power it is their own fault. A tractor generally needs very little attention, but like all machinery, requires care.

Where several departmental organizations are jointly responsible for anything, as in the case of turntables, they each frequently form the habit of waiting on the others to take action. If the locomotive house and maintenance forces will only form the habit of co-operation, the turntables will all be kept in much better shape with much less work and will afford the minimum of inconvenience to all concerned.

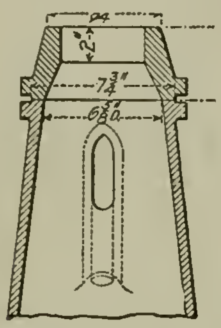
Locomotive Exhaust Nozzles

The prevalent use of water during the summer months for outdoor purposes in cities has, among other things, developed two very different kinds of water sprinklers. The form of the aperture of discharge of water so used plays a most important part in determining the results obtained. The name "nozzle" is given to the spout or pipe for discharge, commonly tapering, and placed at the end of a flexible tube or hose. For want of more definite description they may be called, respectively, the "fire-engine nozzle" and the "garden-sprinkler nozzle." The essential difference between them may be stated more exactly by regarding the first as the one which throws a concentrated stream, and the second as spreading or spraying the water. The object to be gained by the use of the fire-engine nozzle is the throwing of a quantity of water over a comparatively long distance, and delivering it as much as possible in bulk where it will do most good. A fireman is enabled, by the use of a properly designed nozzle, to reach, if need be, the roof of a high building with a powerful stream of water, or to throw it over an inaccessible area to a point where fire is raging. The object sought by the use of the nozzle of the garden-sprinkler kind is, on the other hand, to cover the largest area possible by a diffused and not very violent jet of water.

The construction of the fire-engine nozzle, or one best adapted for the production of a concentrated jet, is that of a gradually tapering tube, through which water under pressure is forced. The tip or extreme end of this nozzle is partially blocked with a square-shouldered ring of metal. An illustration of this form might be given by supposing something like an ordinary plain finger-ring of square section forced into the end of an inch pipe. Another rough approximation to the fire-engine nozzle might also be had by screwing on the end of an inch gaspipe a cap, such as is used by plumbers to close the end of a pipe not required for immediate service, and drilling a three-quarter inch hole in the end of the cap. Either of these illustrations presents an abruptly contracted aperture very similar to that of the fire-engine nozzle, and in some degree not unlike the form of exhaust pipe used in many locomotives at the present time.

When water under pressure is forced down the gradually tapering fire-engine nozzle its speed is uniformly increased, so that at the point of exit it has attained a very much increased velocity. This speed is still further augmented by the partial obstruction of the square-shouldered ring at the extremity of the nozzle. A theory which may possibly help in the understanding of the prin-

ciple upon which this mode of construction is based may be tentatively stated thus: The moving body of water passing through the nozzle encounters a certain amount of frictional resistance offered by the sides of the tapering tube. The particles of water which come in contact



SMALL TIP NOZZLE.

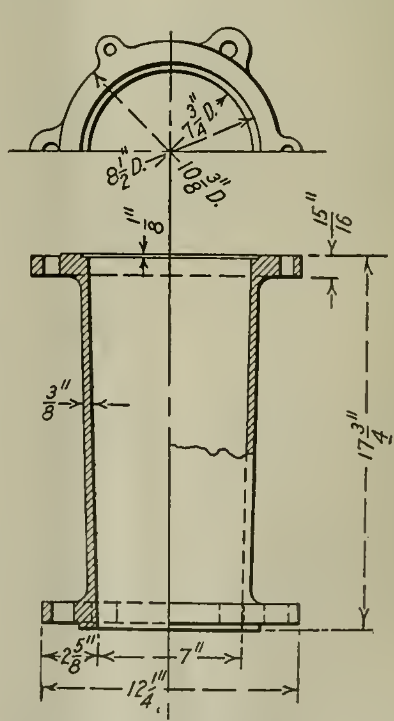
with the walls of the nozzle are rolled along, over and over, thus forming an indefinite series of minute water rollers, upon which the central stream passes with comparatively little frictional obstruction. The square - sectioned ring placed at the nozzle receives the pressure of the numberless little rollers as they progress down the tube, and it has, therefore, from its position and form, a tendency to turn their direction of motion to one at right angles to the general line of motion of the whole body of water. These rolling particles are pressed upon by those behind, and are at last forced to move inward from all sides towards the center of the circular aperture. This inward and toward-the-center motion imparted to the film of water which had passed down along the sides of the tube, and given just at the moment of escape, has probably the effect of neutralizing, in a certain degree, any tendency which the main jet would otherwise have to spread. The sharp ring at the opening makes what hydraulic engineers would probably call the "orifice" in a thin plate or wall. This kind of aperture through a thin plate—thin in comparison to the diameter of the jet—produces a still further slight contraction of the stream just after it has left the pipe; the further contraction outside the orifice being technically called the "veina contracta," or contracted vein. The tendency of the water to spread is therefore delayed by the use of the fire-engine nozzle, and a powerful concentrated and solid stream of water thrown for a considerable distance is the result.

In the garden-sprinkler jet the result is almost completely the reverse. The water moving down this tapered nozzle has its velocity increased as it nears the muzzle, as in the other example. The same phenomena, which for the purposes of illustration have been outlined, may be supposed to exist here also. The exceedingly minute and infinite series of water "ball-bearing" roller particles reduce the friction of the central mass, but at the nozzle the aperture opens out slightly and in a direction different from the gradual tapering of the nozzle walls. It may be said to resemble in shape the old-fashioned, bugle-mouthed blunderbuss. The direction of the emerging particles of water is therefore outward and away from the center line of motion of the whole, and a spraying, scattering jet of or cone of water is thus produced.

If this tentative and roughly sketched working hypothesis be admitted as approximately true, it may be interesting to apply a similar line of reasoning to the consideration of the effect produced by the abruptly contracted nozzle or tip in use on many of the locomotives in service on our various railways. The ordinarily used exhaust pipe is a rough copy of the fire-engine nozzle. The tapering pipe bears a close resemblance to the watertube, and the contracted tip presents a close analogy to the sharply defined partial obstruction of the fire-engine nozzle. The steam from the cylinders is shot out at each exhaust, if not quite, without touching the sides of the smokestack, and in a measure resembles the concentrated jet thrown by the fire-engine. The intermittent character of the exhaust, however, renders it capable of expelling a certain amount of air each time it passes out of the stack. It is able to throw out, at each pulsation, a quantity of air which, for sake of illustration may be supposed roughly to equal in volume that occupied by, say, two or three bottle or non-traversing jacks, standing on end. The quantity is not relatively great with reference to the volume contained in the whole smokestack; but the fact that the concentrated jet of steam is capable of causing a draught, and so stimulating the action of the fire, is to a large extent, dependent upon the violence with which it expels the air. The more rapidly a relatively small quantity of air is driven out at each exhaust, the better will be the draught. The "sharpening" of the draught by the further contraction of the exhaust tip is evidence that the rapidity with which the expulsion of the air is effected is what is most fully relied upon to produce a satisfactory and powerful draught. As each separate exhaust removes a definite quantity of air from the stack and smokebox a further supply of fresh air enters at its only point of ingress, which is through the grates. Various means are employed to cause the concentrated jet to suck air out of the smokebox; but the high velocity of the jet, and its ability to pass out without striking any obstruction, is the end sought.

An innocent, though instructive, experiment may be made by anyone who happens to possess the requisite qualifications. He should have a garden nozzle capable, as many are, of alteration from what will give a spreading or spraying jet, to one which will throw a comparatively solid and compact stream of water, when it becomes necessary to reach the more remote places. If such an experimenter will turn his garden nozzle so that it will throw, as nearly as may be, a solid jet, he will find that the water issues from the nozzle with little or no disturbance to the surrounding air, for a considerable distance from the mouth of the nozzle. The rapidly moving and compact stream of water will pass through the atmosphere as a rod or arrowshaft might do. If he smokes so that a few puffs from his pipe will pass toward the jet, he will find the smoke blow over or under the jet, and that very little will be absorbed by the water. If, however, the nozzle be transformed so as to give a spreading and spraying jet, the smoke blown gently toward the water will be rapidly caught up and disappear in the sparkling cone of water. This seems to show that the spray has the power of producing a certain slight current of air in the direction of the jet, which the other does not seem to possess.

An examination of the steam nozzle of almost any injector will reveal the fact that it has no obstructed tip; its function being to pick up, if one may so say, the water which lies behind and around it,



NOZZLE WIDER AT TOP THAN BOTTOM. TENDS TO SPREAD JET.

as the spraying jet from the lawn sprinkler did with the smoke.

Mr. W. H. Thomas, at one time assistant superintendent of motive power on the Southern Railroad, contributed a most interesting paper to RAILWAY AND LOCOMOTIVE ENGINEERING, which was pub-

lished in the March issue some years ago. In it was given the result of experiments with a nozzle or exhaust tip which was certainly designed to spread or spray the jet of steam, and which purposely caused it to strike the sides of the smokestack in passing out. Such an exhaust takes out, at each release of steam, a stackful of air. This is presumably a much greater quantity than that expelled by steam from the concentrating tip. A large diameter of tip, and consequently a less violent action on the fire, was said to produce most beneficial results. If these facts are as stated, may it not be that the advantage gained by the less violent exhaust is in large measure due to the greater air-drawing quality of the spreading jet.

For sake of illustration, it was supposed that the exhaust from the contracting tip threw out of the stack a quantity of air roughly approximating in volume to, say, that of two or three bottle jacks standing on end, as compared with an entire stackful removed by the steam from the spreading tip. It appeared that the draught on the fire was produced by the very rapid expulsion of the relatively small amount of air, which was driven out almost explosively. The exceedingly rapid removal of the air produced a greater rarefication, not to say vacuum, in the smokebox, and particles of air from without moved with greater rapidity to take the place of those driven out. But here another fact becomes apparent. The movement of air from without toward the firebox, though rapid at each exhaust, is nevertheless for only a short distance each time. This rapid but small movement of air toward the grates is due to the relatively small but violently expelled volume from the smokestack. If the smoker above referred to were to occupy the fireman's seat on a locomotive, running at a high speed, he might have ocular demonstration of this fact. The windows of the cab being shut and the back curtain down, if the damper in the firebox door be slightly opened, the experimenter might watch the behavior of a puff of smoke from his briar root pipe. He would probably notice the smoke first float off in a cloud which would hang motionless for an instant. It would suddenly descend a short distance, perhaps two or three inches, and again remain suspended in the atmosphere for a moment, until the next exhaust drew it rapidly down through a second short distance, the smoke just pausing before again quickly sinking in response to the pulsations of the locomotive. The successive beats of the engine would thus, through the medium of the puff of smoke, be rendered visible in their effects, until the fragrant cloud disappeared through the opening of the fire-door damper. With the use of the spreading tip, a stackful of smoke would be ejected more slowly, though the larger quantity passing out would require a similarly large quantity to come into replace it. It would enter at a relatively slower velocity, and would blow in through the grate bars and play on the fire with an even, more continuous, slightly prolonged, but perhaps more bellows-like effect. A large quantity of air removed slowly and regularly appears to be desirable. Many modifications in exhaust nozzles have been made, but all have been tried with the endeavor to reach the best.

The Brotherhoods Are Intensely Loyal

The leaders of the four railroad Brotherhoods are a unit on the question of delinquency, indifference, carelessness, or "slacking" on the part of employes engaged in the vital service of transportation. This is clearly shown by circular letters sent out by the general chairmen of these organizations to all local chairmen and members on the Pennsylvania Railroad Lines East. The circular letters were issued following the receipt of several communications from the assistant general manager addressed to the four general chairmen and calling attention to a large number of specific instances of failure in duty and other forms of apparent "slacking" on the part of train service employes of the Pennsylvania Railroad Lines East, occurring within the last few weeks.

The four chairmen replied, partly, as follows:

"We assure you of our hearty coöperation, and we trust that steps will be taken to correct matters. We fully appreciate that now that we are all Government employes, it is necessary that there be coöperation, not only on the part of the employes, but also on the part of the officials of the company, so that we may all work as a unit for the Government, for without coöperation we feel that all efforts will fail along the lines of unification of forces for the successful handling of traffic on our railroad."

Mr. William Park, general chairman, Brotherhood of Locomotive Engineers, said: "The man who is failing to report on time, or is refusing to respond when called, is not helping the situation by such action; on the other hand, he is helping to discredit our organization. One must be patriotic when at this critical period there is such an extreme shortage of men in railroad service to move the great volume of freight necessary to keep supplies moving promptly to our armies and those of our Allies.

"If the boys in the trenches failed to report promptly, or failed to respond when ordered to do so, as some of our railroad men are doing, serious things would result, yet by a general order the President has placed us all in the same category with the soldiers. We are just as much a part of this great war machine, our duties are just as great, our responsibility is even greater, for if we fail or if we all should do as a few are doing (failing to respond when called), the result would be appalling.

"A spirit of coöperation should take hold of every branch of service, to the end that we may serve our country faithfully and efficiently. A spirit of mutual helpfulness should pervade every part of our lives in this time of Democracy's great struggle for the world's freedom from autocracy."

Mr. H. E. Core, general chairman, Brotherhood of Locomotive Firemen and Enginemen, wrote as follows: "As members of an honorable organization we are all duty bound to do all in our power to assist officials of the company in the prompt, efficient and safe movement of engines and trains, and to see that all firemen and hostlers properly, promptly and efficiently do their duty while in the service of the company.

"The long list in the assistant general manager's letters, among whom are employed many firemen, shows a seriously demoralizing tendency towards inefficiency among many engine and train service employes. If this is not promptly and effectively checked, it must inevitably injure the good repute of our organization, and the good name of the firemen and hostlers as efficient working men, and loyal and patriotic citizens.

"I therefore urge upon you all to do all in your power to see that every fireman and hostler is careful to perform all his duties. Industrial slacking has a seriously demoralizing effect on the efficiency of railroad service in the movement of all trains now so vitally necessary. Industrial slacking in any of its forms is as great a menace to the safety of our country as any pro-German propaganda can possibly be."

It is everywhere apparent that the men who do the work of railroading are intensely loyal to the United States. They have abandoned weak compromise and are determined to aid the government in every way to win the war.

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Win the War.

It is a pretty well accepted fact that no man can please everybody all the time, and as this is so, it is equally true that no one man, holding a responsible position, where thousands look for, and act on his word, can possibly satisfy everyone in the community. The Director General of Railroads has had new work, to him, to perform, he has little intimate knowledge of those who, from the nature of the case, must advise him. Think this over. You may not agree with everything that has been done; but could you do much better yourself? Well hardly! Then turn in and give all the help to him that you can.

Part of the time for getting equipment ready for the winter is gone, though not all of it. Now is the time to get in and work, and so aid in winning the war. We are not likely to have quite so bad a winter this year as we had last year. We mean there may not be the long periods of intense cold, or as much snow, but it will be bad enough. We do not want to make it more severe by being unprepared, or by underestimating it. We can't afford to have the transportation system of this country deranged during the war, if we know how to prevent it. Now is the time to lay aside all fault finding, hostile criticism, and slackness. Everyone can't be captain of the ship at the same time. Lend a hand, we must win the war.

Locomotive Repair Shop Output.

From reports that come to us from the railroads now in the hands of the Federal Administration officers it appears that the repair work on locomotives is being accomplished with a degree of thoroughness and rapidity that surpasses the record of previous years. This speaks volumes for the loyalty and increased energy of the skilled mechanics engaged in the work. The liberal increase in remuneration made by the government has doubtless much to do with this. Men who are fairly well paid may be relied to do more than those who are kept on starvation wages. That machinists and others engaged in locomotive repair work have not been paid as well as they should have been for many years is universally conceded. It is not necessary to dwell on the causes that have conduced to this deplorable state of things. That it was partly owing to harsh legislation and partly to the lack of unity among the employes themselves is well known.

Again many of the railroads suffered from a constant change in the ranks of the workmen. Assuming that a man is a good mechanic he will not develop 100 per cent. of efficiency until he has been in the service a certain length of time, as there will be conditions with which he is not familiar and it takes time to educate him. In addition, mechanical departments have experienced in the past delays on account of shortage of material. This is not a reflection on the stores department, but due to the fact that retrenchments were necessary and they could not order material far enough in advance to prevent shortages.

Again in many instances the shops were not permitted to remain in full operation all the year round. A great saving is effected by maintaining a steady staff, and in this way the mechanical department could figure on a certain number of engines falling due for the shop each month, whereas during the past several years the greater proportion of heavy locomotives have been put through the shops in many of the railroads in the summer or fall months, which makes them all fall due about the same time the following year, and this is a condition which works hardships in the mechanical and operating departments. Supposing a railroad receives a number of new locomotives about this time and under ordinary conditions these engines remain in service approximately fourteen months, necessitating shop attention about the end of the year, when in all probability there is the greatest demand for their service. The necessity for retrenchment in the output of a shop in the summer months, prevents the repairs to other locomotives in the same class, making a shortage of power and congestion, which would make it inadvisable to repair these engines when due. To relieve a situation of this kind, it is occasionally necessary to advance the regular date of shopping to prepare the heaviest power for the service in winter months, and this necessarily increases the maintenance cost, also necessitates the engines continuing in service longer than their condition would warrant, probably decreasing the number of miles run for failure, and unless these conditions are fully considered it is hard to maintain the maximum of efficiency expected.

Electrification of Railroads.

We commend to our readers a careful perusal of the able paper on Railway Electrification, the bulk of which appears elsewhere in our columns. The degree of fairness with which the subject is handled is admirable, and while it would be idle to venture an opinion as to the feasibility of the general recommendations set forth, it is to say the least worthy of that serious degree of consideration which the gravity of the fuel situation calls for, that the advantageous use of electricity as a motive power from an economic standpoint in certain districts is unquestioned is universally admitted. Not only so, but apart from the economical advantages there are other advantages, particularly in suburban districts, where it has almost become a primal necessity, as its success in many ways is so marked.

In the districts particularly referred to by Mr. Murphy, the author of the paper, where water power is abundant, the more rapid adoption of electric power is merely a question of time. Not only so, as is shown by the reports from the electrified districts of the Chicago, Milwaukee & Western, but on the Norfolk & Western where the supply of coal is conveniently near, the increase in power and reduction of maintenance is clearly established. On the other hand districts less fortunate in these regards look upon the adoption of electric power as prohibitive. As an instance, the proposition to electrify the railroads in Chicago and vicinity was found by most careful investigation to be impractical from a financial standpoint. It simply meant bankruptcy, and, as is well known, many of the railroads have been long on the brink of ruin already.

Perhaps the most gratifying feature of the attempts to solve the fuel problem, and incidentally, the great and growing transportation problem, is to note that the best and brightest minds among the engineering fraternity are engaged in the solution of these problems, and in no country in the world is there a more ready recognition or encouragement to be found than in the highly charged atmosphere of American enterprise.

Railroading As It Is and As It Will Be.

The unfortunate accident which recently occurred on the N. C. & St. L. Ry. has focused public attention on the things

that may happen on a well equipped and efficiently run railway. The well known verdict that the dead engineman was to blame, which has hitherto very largely suited each species of accident as the "Amen" suits any Anglican church hymn, does not appear to be fully acceptable to the Director General of Railroads. If a man failed, be he now dead or alive, it is quite possible to arrive at some sort of rational explanation of his failure, or at least the probable causes of his delinquency. Failure, as we have more than once pointed out may be psychological.

Who is to say what interpretation the mind of a busy engineman will give to a colored signal light, when squinted at sideways when only the short, straight faces of the signal lens are seen? Scientific men would call this extra Fovial vision directed to the parallel surfaces of a Fresnel lens. What they mean is this, that there is on the optic axis of the eye, that is the direct line of sight, a depression or shallow pit on the retina of the eye and this small area is called the "Fovia Centralis." It is the area of sharpest and most definite sight, and to bring this small area in the direct line of sight, explains why we move our eyes to see an object most clearly. All the rest of the area of the retina falls short of that given by the Fovia.

The object of a semaphore lens is to project parallel lines of light from the flame in the lamp. In order to bring the lens down to a satisfactory size the lens which theoretically might stand out 12 inches or more from the lamp is, if we may so say, compressed to perhaps 2 inches, so that there are a number of small flat surfaces parallel to the lines of light, but these small areas or rings in the lens are not designed to scatter or diffuse the light though being made of glass some small amount of light can get through.

Now, as we said before, who can say positively what interpretation the mind of a busy man may put upon light following a path which is rather accidental than of design and reaching the retina of the eye where vision is not at its best? It may give a distorted impression, or it may not even stimulate conscious appreciation, especially if the man has his thoughts engrossed by something else. There is certainly some danger in this condition. This is one example; others could easily be found.

We have previously spoken of the distractions of work on the engine, of thoughts of home and friends or even hopes of gain. The effects of a quarrel and the endeavor to think out an explanation for some previous act, likely to be called in question, may also dull perception to the danger point. Or even a temporary fit of drowsiness may do it.

We cannot speak in too high terms of praise of the desire of the Director General to seek out the cause and so adjudge the adequate remedy. Such a course will inaugurate a far safer style of railroading than we have hitherto had. We are not concerned with how far other nations have gone in this matter. This is a subject pertinent to the American Railroad System as it stands, and we alone suffer the loss caused by what may be called, preventable accidents, and we alone must apply the remedy.

Some sort of automatic stop device, put in operation in case a train, from whatever cause, is forced past a signal which "advises" stop, but does not enforce it, is the desideratum in this day. We believe the administration has an opportunity of conferring upon the people one of the best promises for safe railroad operation in the world, and we believe that the government intends to give this important matter most serious thought, and will act in such a way as to ennoble its own reputation and confer a priceless boon on the traveling public, the significance of which can only today be imagined.

There are many train control and stop devices to be had. A committee of practical, competent, cool, expert signal engineers and a sprinkling of those whose duty it is to look at, and obey signal indications, if got together, and for the time being, removed from the pressure of home duties, would be able to give a clear, straightforward statement of what is required, and these men, looking at many devices, would weed out the ineffective and leave perhaps a dozen or so that had real merit. It is not necessary to say that all these devices would be perfect, but they would not be beyond improvement. Healthy rivalry would cause the advocate of each specific design to look for and eliminate the suspicion of a weak spot in his device, but the grand movement of all would be toward the same goal.

It is not to save one accident that this time and thought and money must be expended. It is not that one railway may plume itself on its record. It is for a higher and greater result that the government takes action. It is a result which comports in exalted, patriotic and high emprise, with the dignity of the powerful agency of the national government. A momentary mental abberation, a drowsy moment, a misread signal, a preoccupied mind, a passing quarrel, may cost the lives of many, and darken the homes of scores of innocent victims. No more noble, praiseworthy and glorious work was ever resolutely taken up by the administration than this of making the great land transportation system safe for the people, and no one can do it as the government can and will do it, thoroughly and splendidly. It is government of the people, by the people and for the people.

Increase of Wages for Shopmen.

The railroad shopmen of the country have recently come in for recognition in the way of an increase of pay at the hands of the Director General. It may be said that this is not so much an act of generosity as it is of justice. Whatever raises of pay, from time to time may have gladdened the hearts of railroad men, the shopmen have seldom been part of the glad throng.

The work of the shop man is onerous and hard, his toil is just as unending as any other branch of the service. He now has the right to feel that his increasing usefulness and experience is being counted in the scale in his favor. There is no feeling so filled with satisfaction as the frank admission of one's ability by another. The feeling is more to be prized than winning a fight though the feeling of triumph is strong.

The advance of wages affect about 500,000 men and apply to all over the country. The addition to the aggregate annual payroll is estimated at nearly $100,000,000. The advance is the first extensive modification of the new wage scale, and was made on recommendation of the commission on railroad wages and working conditions.

The new scale of wages was announced as follows:

Machinists, boilermakers, blacksmiths, sheet metal workers, moulders and first class electrical workers, 68 cents an hour; carmen and second class electrical workers, 58 cents an hour; helpers, 45 cents an hour; foremen paid on hourly basis, five cents an hour more.

Foremen paid on monthly basis, increase of $4 a month; minimum $155 and $250.

The wage advance has been made retroactive, and the increases therefore date from January 1, 1918. From August 1 eight hours will be recognized as a standard working day, and overtime for Sunday and holiday work will be paid for at the rate of time and a half. Back pay will be given the men as soon as it can be calculated. Viewed in any light it is a matter for congratulation to the shopman of this land that the wage increase has been given as it has, without a fight and that the amount paid to each man will help to lighten the increasingly heavy financial burdens which the war, and the higher cost of necessaries brings with it.

Railroad service, with its many and its varied activities, is a complicated piece of business, and it is by no means easy or soft work. Its exactions are persistent and its call is imperative. The increase of wages, though it may look large in the aggregate, is no more than the stenographer in an office or the clerk in a dry goods store, has a moral right to look for as an individual recognition of his full and faithful service

Air Brake Department

Brakes Failing to Release — Questions and Answers

We have received several inquiries relative to brakes failing to release on passenger trains, particularly with LN equipment, and a few comments upon this subject should be of general interest. The failure of a brake to release, provided that the exhaust port of the operating valve is open and no air pressure escaping, that the brake rigging is not fouled, or that a hand brake is not set, means, of course, that for some reason or reasons, brake pipe pressure cannot be increased above the pressure in the auxiliary reservoir sufficiently to force the triple valve piston and slide valve to release position. When the triple valve is in a reasonably good condition, or where several brakes in a train have failed to release, it means that the supplementary reservoirs have charged the auxiliary reservoirs to a higher pressure than there is contained in the brake pipe. With PM equipment, the same result is obtained if the auxiliary reservoirs have been charged to a higher pressure than that being maintained in the brake pipe. This overcharge of the auxiliary reservoir may be obtained from allowing the brake valve handle to remain in release position for too long a period, or from some other engine having handled the cars with a higher brake pipe pressure or a higher pressure may have been admitted from a yard testing plant, in any event, the stuck brakes should be released from the engine, whether in road or shifting movements, as to release a brake by means of bleeding the reservoirs is usually a waste of compressed air, which may result in the application of other brakes in the train, and, obviously, if brakes are released by means of bleeder cocks or drain cocks, it gives no assurance that the brakes can be released by the engineman or from the engine.

There are, however, shifting conditions wherein it is argued that in some instances time may be saved by bleeding off a brake that fails to release promptly, as in the case of coupling fully charged cars to others that have no air pressure in the brake system, and it must be admitted that under certain conditions a train movement may be facilitated by bleeding off a brake or brakes.

With the LN equipment, a movement of the triple valve to release position, after an application of the brake, opens the supplementary reservoir to the auxiliary, and as the supplementary reservoir volume has not been disturbed during a service application, and its volume being approximately, two and a half times that of the auxiliary, the auxiliary reservoir pressure is increased from the supplementary reservoir at about the same rate that brake pipe pressure is increasing, up to the point of equalization between the two reservoirs, therefore it is only necessary to increase the pressure in the brake pipe alone in order to effect a release.

When the brake pipe pressure for any reason cannot be increased above the equalizing point between the reservoirs, the brake remains applied, or graduates the release, retaining a portion of the pressure in the brake cylinder, or the release of air from the brake cylinder is in proportion to the amount admitted from the main reservoir into the brake pipe. While we contend that the brake should be released from the engine, if it ever becomes necessary to release a brake by means of the bleeder cocks in the reservoirs, it should be done by means of the release valve or drain cock of the auxiliary reservoir. This should be opened until the triple valve starts to discharge brake cylinder pressure, and the bleeder cock should be closed immediately, and again opened as the brake graduates, and to be repeated, if necessary, the object being to release the brake, by exhausting the least possible amount of air from the auxiliary reservoir.

Bleeding the supplementary reservoir at such a time involves an unnecessary waste of compressed air, as the supplementary reservoir is not in communication with the auxiliary when the triple valve is in service, service lap or graduated release lap position, and the brake cannot be released by bleeding the supplementary reservoir until this pressure has lowered sufficiently to allow the bypass valve to open, and the pressure must be reduced to about 40 lbs. to permit the by-pass valve to permit air to pass from the auxiliary to the supplementary reservoir. In any event, it is a waste of compressed air that must be restored from the locomotive.

When supplementary reservoirs become overcharged, that is, charged to a higher pressure than the brake pipe pressure as controlled by the feed valve, the pressure is reduced by making an application of the brake and during release, each time the triple valve moves to release position a portion of the supplementary reservoir pressure will be used in recharging the auxiliary, and if the reservoirs are very highly overcharged, several full service applications of the brake may be necessary to effect a complete release. During such operations, the supplementary reservoir pressure drops about 1 lb. for every 4 lbs. increase' in the auxiliary reservoir, this taking into consideration the amount that may enter the auxiliary from the brake pipe, which is a very small amount. From this it is evident that a 20 lb. brake pipe reduction, resulting in a 20 lb. auxiliary reservoir reduction would drop the supplementary reservoir pressure 5 lbs. during a release, or a 30 lb. reduction would cause a loss of 7½ lbs. in the supplementary. In this connection, it might be well to state that the secondary charging port from the brake pipe to the auxiliary reservoir opens when the brake pressure is 4 lbs. higher than that in the auxiliary reservoir, but the auxiliary reservoir is charged principally from the supplementary.

The greatest difficulty in brakes of this equipment failing to release is during a test of brakes, conducted immediately after a train is made up and the various cars have been charged from some different sources and when a difference in supplementary reservoir pressure on the various cars exists. If after an application of the brake, the brake pipe pressure cannot be promptly increased above the point of equalization of the highest charged supplementary reservoirs and their auxiliary those brakes will remain applied while those with lower pressures are released and recharging. When trains are made up in such a manner, the brake pipe reduction for the test should never be less than 30 lbs., not for the purpose of insuring an application of the brakes, but to so far as possible, insure a satisfactory release of brakes. Under conditions where there may be as much as 15 or 20 lbs. difference in supplementary reservoir pressures, and where it is understood that brakes are ready for test with LN equipment when the pressures have equalized, which does not necessarily mean the supplementary reservoir pressures, the best method is to make a brake pipe reduction that will reduce the auxiliary reservoir pressure to 60 lbs., this giving the maximum amount of drop in the reservoirs that will tend to insure a release of brakes. Where it is possible to charge all reservoirs to a uniform pressure, the amount of brake pipe reduction for the brake test is of very little consequence as effecting the release, provided that it is not less than 15 lbs.

It is generally understood that testing brakes with LN equipment with less than standard pressure is permissible, when it is understood that this brake with 90 lbs. pressure is more effective than the PM equipment with 110 lbs. pressure.

Questions and Answers

Locomotive Air Brake Inspection.

(*Continued from page 226, July, 1918.*)

410. Q.—Can this brake be released with the straight air valve after an application with the automatic brake valve?

A.—Not with the S-3 brake valve, but it can be with an S-3-A brake valve.

411. Q.—After having made the 27 lbs. brake pipe reduction during the test, is the brake valve allowed to remain in release position as when inspecting the E. T. brake?

A.—Yes.

412. Q.—Why?

A.—To make a comparison of the air gauge hands.

413. Q.—What is the next brake valve movement?

A.—Same as for the E. T. equipment, the brake pipe is reduced to 110 lbs. and the rate of equalizing reservoir reduction timed from 110 to 90 lbs.

414. Q.—Is this time the same for the G-6 and H-6 brake valves?

A.—Yes.

415. Q.—What is the time if the equalizing reservoir pressure is 70 lbs. and a 20 lb. reduction is made as with the engine in freight service?

A.—9 to 11 seconds.

416. Q.—Are these two applications sufficient for the automatic brake valve test?

A.—Yes.

417. Q.—What test is made with the straight air brake valve?

A.—An application to see that the brake will be instantly applied, and a movement to release position to see that the release is prompt.

418. Q.—What would cause a blow at the exhaust port of a driver brake triple valve when both brake valves are in release position?

A.—A leaky triple valve slide valve.

419. Q.—What would cause the blow only at a time the straight air brake is applied?

A.—A leak past the automatic side of the driver brake double check valve.

420. Q.—What would cause a blow at the exhaust port of the straight air brake valve when both brakes are released?

A.—A leaky application valve in the straight air brake valve.

421. Q.—If the straight air brake was applied?

A.—A leaky exhaust valve or a leaky handle shaft washer.

422. Q.—What would cause a leak here only at a time the automatic brake was applied?

A.—A leak from the straight air side of one of the double check valves.

423. Q.—Can you tell which one would be at fault?

A.—Yes.

424. Q.—How?

A.—By trying the brake with the tender brake triple valve out, which would eliminate the tender check valve from the disorder.

425. Q.—What would cause a leak at the exhaust port of a quick action triple valve on the tender only at a time the straight air brake was applied?

A.—A leaky seat at the automatic side of the tender double check valve.

426. Q.—What would cause a blow at a time that both brakes are released?

A.—A leaky triple valve slide valve, a leaky emergency valve seat, a leaky check valve case gasket or a leaky triple valve body gasket of the tender triple valve.

427. Q.—How can the source of the leak be determined?

A.—By closing the cut out cock in the brake pipe branch leading to the triple valve.

428. Q.—What is wrong if the brake then applies?

A.—The leak is from the brake pipe.

429. Q.—Which defects cause this?

A.—The leaky emergency valve seat or the leaky check valve case gasket.

430. Q.—What if the brake does not apply when the stop cock is closed?

A.—The leak is from the auxiliary reservoir pressure.

431. Q.—Which parts could be at fault?

A.—The triple valve body gasket or the slide valve.

432. Q.—How can the difference be determined?

A.—By recharging the auxiliary reservoir and making a 10-lb. brake pipe reduction.

433. Q.—What is wrong if the brake applies and the blow stops?

A.—Usually the body gasket is defective.

434. Q.—What would be wrong if the blow continued after the brake applied.

A.—The triple valve slide valve would be leaking.

435. Q.—Why are you positive of this?

A.—Because the triple valve slide valve should close the triple valve exhaust port when the brake is applied.

436. Q.—Where is a leak at the emergency exhaust port of the automatic brake valve from?

A.—From a leaky rotary valve in the automatic brake valve.

437. Q.—A leak at the brake pipe exhaust port of the automatic brake valve?

A.—Same as with the E. T. equipment.

438. Q.—What would cause either one of these brake equipments to apply with both brake valves in running position?

A.—Brake pipe leakage and an overcharged brake pipe, or brake pipe leakage in combination with a defective feed valve.

439. Q.—How is the brake cylinder leakage test made on an engine that has no straight air or independent brake?

A.—By making a 15-lb. brake pipe reduction and returning the brake valve handle to lap position.

440. Q.—Is this a fair test?

A.—Yes, if there is no brake pipe leakage in excess of 10 lbs. in five minutes.

441. Q.—Why is the test unfair if there is a greater amount of brake pipe leakage?

A.—Communication with the brake cylinders will not be closed as required by the Federal regulations.

442. Q.—What is the actual object in making but 15 lbs. brake pipe reduction, when the instructions permit of a full service reduction?

A.—If the reduction is 15 lbs. and the brake pipe leakage is 10 lbs. during the time of test, the total brake pipe reduction will have been 25 lbs. and if the brake remains applied for a period of 5 minutes under the conditions the rules of the Interstate Commerce Commission will have been complied with.

443. Q.—How is an accurate leakage test made with this brake?

A.—By attaching an air gauge to the exhaust port of the triple valve, and making a full service brake pipe reduction and returning the valve handle to running position.

444. Q.—How can the test be made in the driver brake when there is a special retaining valve or stop cock attached to the triple valve exhaust port?

A.—By closing the cock in the retainer pipe and making the full service brake application and returning the brake valve to running position.

445. Q.—How long must the brake remain applied on any locomotive or tender with communication to the brake cylinders closed?

A.—For five minutes' time.

446. Q.—What would be wrong if the brake leaked off very quickly when using a retaining valve or cut-out cock for the brake cylinder leakage test, but the brake appeared to be holding very well, when the retaining valve was not used?

A.—It would indicate that the leakage was in the piping attached to the triple valve exhaust port.

(*To be continued*)

Train Handling.

(*Continued from page 227, July, 1918.*)

432. Q.—What if the sticking was primarily due to low steam pressure on the locomotive boiler?

A.—The brake valve handle would be allowed to remain in release position until the steam pressure was regained.

433. Q.—Why?

A.—To add the main reservoir volume to that of the brake pipe.

434. Q.—Of what advantage would this be?

A. Any leakage that would have a tendency to apply the brakes would then have to reduce the main reservoir pres-

sure as well as that in the brake pipe before an application of the brake could take place.

435. Q.—Explain further?

A.—The reduction of brake pipe pressure through openings of a fixed size in the brake pipe would be compelled to reduce a greater volume which would require a greater length of time than if the leakage was from the brake pipe alone, consequently permitting of more time for the air from the auxiliary reservoirs to feed through the triple valve feed grooves into the brake pipe and thus lower the pressures throughout without resulting in a brake application.

436. Q.—When would the valve handle be returned to running position?

A.—When steam pressure is sufficient to bring the brake pipe pressure very nearly up to the adjustment of the feed valve.

437. Q.—What may be done in an effort to maintain the brake pipe pressure against leakage while excess pressure is being accumulated for the operation of the feed valve?

A.—An occasional movement of the brake valve to release position may be made, great care being taken not to overcharge the brake pipe and auxiliary reservoirs at the head end of the train.

438. Q.—What are the chief causes of slid flat wheels in passenger service?

A.—Bad condition of rail, unequal braking forces, defective equipment and incorrect manipulation of the brake valve.

439. Q.—How can unequal braking power cause wheels to slide?

A.—By momentarily creating differences in speed between the various cars in the train.

440. Q.—How does the difference in speed cause it?

A.—A car moving along at a uniform rate of speed, with the brake applied, if suddenly pushed or jerked to a faster rate of speed, will tend to drag the wheel along the rail for the reason that the speed of the wheel being controlled by the brake shoe cannot increase at the same instant that the car body changes speed, hence the adhesion of the wheel to the rail is broken and the wheel slid along on the rail.

441. Q.—Why will heavy reductions at low speeds tend to cause wheel sliding?

A.—Because a greater brake shoe friction is obtained at low rates of speed, and in the event of a bad condition of the rail, the adhesion of the wheel to the rail may be broken.

442. Q.—Is wheel sliding affected by thin brake shoes?

A.—Yes, for the reason that the thin shoe tends to a quick rise in temperature and momentarily creates a greater holding power than the ordinary thickness of shoe.

443. Q.—Does the thin shoe continue to give greater retarding effect than the heavy shoe?

A.—No, the shoe is quickly heated to a point where it will give less retarding effect than the heavier shoe.

444. Q.—Will the wheel to which the thin shoe is applied then start revolving?

A.—No, not until the brake shoe pressure is almost entirely removed from the wheel.

445. Q.—What rule is generally considered to be correct with reference to locked wheels starting to revolve?

A.—That once they are locked they will remain locked or sliding until the brakes are released.

446. Q.—Given ample time, can a train be stopped on a bad rail without serious injury to the wheels from sliding?

A.—Yes, but it also requires ample distance, and sometimes several applications of the brake during the stop.

447. Q.—Is wheel sliding to be considered in cases of emergency?

A.—No. Failure to use the emergency brake in actual cases of emergency might be construed to appear as criminal neglect; however, there is no doubt but that under certain conditions as to a bad rail and moderate rate of speed a shorter stop could sometimes be made with a prompt service reduction.

448. Q.—Why is this?

A.—For the reason that a wheel sliding on the rail will usually move further than if it was revolving with a brake shoe applied to it for retarding the speed of the wheel.

449. Q.—How is application to steady a train around a curve made?

A.—The application and release is made before the train enters the curve.

450. Q.—Why?

A.—Releasing brakes while a passenger train or the rear end of it is in a curve is generally regarded as bad practice.

451. Q.—How heavy a brake pipe reduction is to be made?

A.—The same as outlined for any other stop.

452. Q.—Are there any circumstances under which a series of light reductions would be of advantage?

A.—Yes, if it was found that the brakes were working in undesired quick action every time a heavy reduction was made, but worked properly on light reductions.

453. Q.—What could cause such an action of the brake?

A.—A partially closed service port in a triple valve.

454. Q.—Why would the light reductions not cause quick action?

A.—More time would be allowed for the auxiliary reservoir pressure to pass through the restricted service port.

455. Q.—Are there many triple valves found to be in this condition?

A.—No, the use of standard test racks has almost entirely eliminated this disorder.

456. Q.—Ordinarily, will the light reduction tend to avoid or produce undesired quick action?

A.—It will tend to produce the disorder.

457. Q.—In what manner?

A.—In the same manner that brake pipe leakage will tend to cause the disorder when the brake valve handle is allowed to remain in lap position for a short time before a brake application is started with the brake valve.

458. Q.—How many contributing disorders are there in a brake system that may be partly responsible for a case of undesired quick action?

A.—About 45.

459. Q.—How would the brake valve be handled if quick action occurred every time the brake valve was placed in service application position?

A.—The train could be run in close to the point at which the stop is desired and the brake valve be used in emergency position.

460. Q.—For what purpose?

A.—To have the quick action initiated at the head end of the train.

461. Q.—Why will this be more desirable than to have it emanate from the rear end?

A.—There is considerably less likelihood of the emergency application parting the train.

462. Q.—Does a quick action or emergency application cause a serious shock to a train running at a high rate of speed?

A.—As a general proposition it does not.

463. Q.—Why not?

A.—Because the wheel is revolving rapidly and the retarding force of the shoe is very low at high speeds as compared with lower rates of speed.

464. Q.—Can the second engine of a double header be of any assistance in charging a train?

A.—Yes, a man with a good general knowledge of air brakes would almost unconsciously cut in his brake valve and assist until the brake pipe pressure was very near the maximum to be carried.

465. Q.—Would the second man ever cut in to assist in charging a train in descending a grade?

A.—No. Because of the probability of interfering with the brake operation and the possibility of forgetting to again cut out he would leave the brake valve cut out cock closed and allow the lead engineer to handle the brakes.

466. Q.—How can the second engineer render assistance during the release of the brakes on a freight train in motion?

A.—By placing the independent brake valve on lap position when the brake valve on the first engine is moved to release position.

467. Q.—What will this do?

A.—Assist the head engine and the K triple valves on the train to hold in the slack by holding the brake on the second engine applied.

468. Q.—How will the second man know when the first brake valve is moved to release position?

A.—By the increase in pressure shown on the No. 2 air gauge, and by the escaping of application cylinder pressure from the brake valve exhaust port.

(To be continued)

Car Brake Inspection.

(*Continued from page* 228, *July,* 1918.)

415. Q.—If 10,000 lbs. pressure is delivered to the floating lever, and the force is delivered to the middle hole of the lever and the distances to the top rod and the hand brake stop are equal, what will be the pressure delivered to the top rod?

A.—5,000 lbs.

416. Q.—Why?

A.—Because 10,000 lbs. has been delivered to the pull rod and 5,000 lbs. is then delivered to the hand brake stop and the top truck rod.

417. Q.—What will this force then deliver to the brake beam with the same proportion of truck lever previously mentioned?

A.—20,000 lbs.

418. Q.—And how much to the entire four beams?

A.—80,000 lbs.

419. Q.—With 20,000 lbs. per beam how much pressure will be delivered to each brake shoe?

A.—10,000 lbs.

420. Q.—Assuming that the brake shoe is pressed against the wheel with a force of 10,000 lbs., and the coefficient of friction average 10 per cent, what will be the actual average holding force or retarding force in pounds that is tending to check the rotation of the wheel?

A.—10 per cent of 10,000 lbs., or 1,000 lbs.

421. Q.—If the coefficient of adhesion is as low as 15 per cent, what will be the actual force in pounds acting to keep the wheel revolving while the brake shoe is applied?

A.—15 per cent of the weight of the wheel on the rail, which is 11,111 lbs. from the car weight assumed.

422. Q.—How much is this force in pounds?

A.—1,666 lbs.

423. Q.—What would the latter force be if the coefficient of adhesion was 20 per cent, which could be expected with a good condition of the rail?

A.—20 per cent of 11,111 lbs. or 2,220 lbs.

424. Q.—Suppose that the car was of a modern construction and it was desired to use a high emergency braking ratio, say 180 per cent, what pressure would then be developed at the brake shoe?

A.—Twice the service brake shoe pressure, or 20,000 lbs.

425. Q.—If the 10 per cent average coefficient of friction was then obtained, what would be the actual retarding force of the brake shoe on the wheel or the force that can be measured by the pull on the brake beam hanger?

A.—10 per cent of 20,000 lbs., or 2,000 lbs.

426. Q.—With 2,000 lbs. actual force tending to check the rotation of the wheel, and 2,220 lbs. actual force in pounds tending to keep the wheel rotating, will the wheel slide?

A.—No, the wheel cannot pick up and slide until the force tending to check the rotation of the wheel overcomes or is greater than the force tending to keep the wheel revolving or in motion.

427. Q.—In other words, when do wheels slide?

A.—When the frictional force between the shoe and the wheel exceeds the adhesional force obtained between the wheel and the rail.

428. Q.—Is this calculated brake shoe pressure delivered to the brake shoes in actual practice?

A.—No.

429. Q.—Why not?

A.—Account of the losses encountered through movements of levers and from compressing brake beam release springs and the brake cylinder release spring and any other release springs that may be employed moving the brake shoes away from the wheels when the brake is released.

430. Q.—About what per cent of the calculated brake shoe pressure is actually delivered?

A.—With a fairly good design of foundation brake gear about 85 per cent of the force calculated from the area of the brake piston is delivered to the brake shoes.

431. Q.—What does this indicate in the way of deciding upon the emergency braking ratio that may be safely employed on modern passenger cars without encountering the liability of wheel sliding?

A.—That an emergency braking ratio of from 150 to 180 per cent may be used.

432. Q.—With this same car assumed, under what conditions would wheel sliding likely occur as a result of a brake application during a stop?

A.—If the coefficient of brake shoe friction was to reach as high a figure as 23 or 25 per cent and the coefficient of adhesion due to a poor condition of the rail was as low as 15 per cent so that the 1,666 lbs. force tending to keep the wheel rotating would be exceeded by 23 or 25 per cent of an actual 8,500 lb. brake shoe pressure.

433. Q.—If these forces are known, or if it can be determined just what retarding force will be obtained by an application of the brake, can the distance in which a car or a train of cars will be stopped be calculated?

A.—Yes, if all of the factors entering the problem are known the stop distance can be calculated to an inch.

434. Q.—What becomes of the energy exerted or expended by the locomotive in bringing a train from a state of rest to a high rate of speed?

A.—It is stored in the train.

435. Q.—What is this usually termed?

A.—The kinetic energy in the train.

436. Q.—What becomes of this energy when the train is being stopped?

A.—It is being dissipated.

437. Q.—What must occur before the train can stop?

A.—The energy stored in the train by the locomotive must be destroyed or dissipated by the action of the brakes before the train can be stopped, unless the train is allowed to run a sufficient distance for the energy to naturally dissipate itself, through journal friction and atmospheric resistance.

438. Q.—How is the energy or amount of foot pounds energy stored in a moving body found?

A.—By multiplying one-half of the mass by the square of the speed at which the body is moving.

439. Q.—What is the mass?

A.—The weight of the body divided by the acceleration due to gravity.

440. Q.—What is the acceleration of gravity?

A.—32.8 feet per second.

441. Q.—Is there any formula that can be used for calculating a train stop distance with modern types of air brakes and foundation brake gear?

A.—Yes, a fairly accurate calculation may be made as the variable factors are fairly well known or rather have been determined from air brake tests.

442. Q.—What is this formula?

A.— $$\frac{N^2}{2gPef}$$

or the square of the velocity divided by twice the acceleration of gravity times the nominal percentage of braking power times the efficiency of the brake rigging times the average coefficient of brake shoe friction obtained during the stop.

443. Q.—To be a trifle more explicit, what does g represent?

A.—The acceleration due to gravity, or 32.2 feet per second.

444. Q.—What does P represent?

A.—The nominal or calculated percentage of braking ratio employed.

445. Q.—And e?

A.—The efficiency of the brake rigging in per cent.

446. Q.—And f?

A.—The average co-efficient of brake shoe friction during the stop.

(To be continued)

Railway Electrification

An interesting and instructive paper on Railway Electrification was recently read before the Canadian Society of Civil Engineers by Mr. John Murphy, C. E. Electrical Engineer, Railways and Canals Department, and Board of Railway Commissioners, from which we quote the following: No argument is required to support the contention that eliminating the need for coal at a considerable distance from the mine is a greater measure of relief, and of true conservation, than increasing mine production and thereby incidentally adding more load to the already overburdened railways. Reducing coal consumption automatically relieves or releases men and apparatus all along the route from the mine to the consumer; it also relieves the route itself from some of its congestion. So eminent an authority as E. W. Rice, president of the American Institute of Electrical Engineers, addressing that body in New York recently, made the following statement:

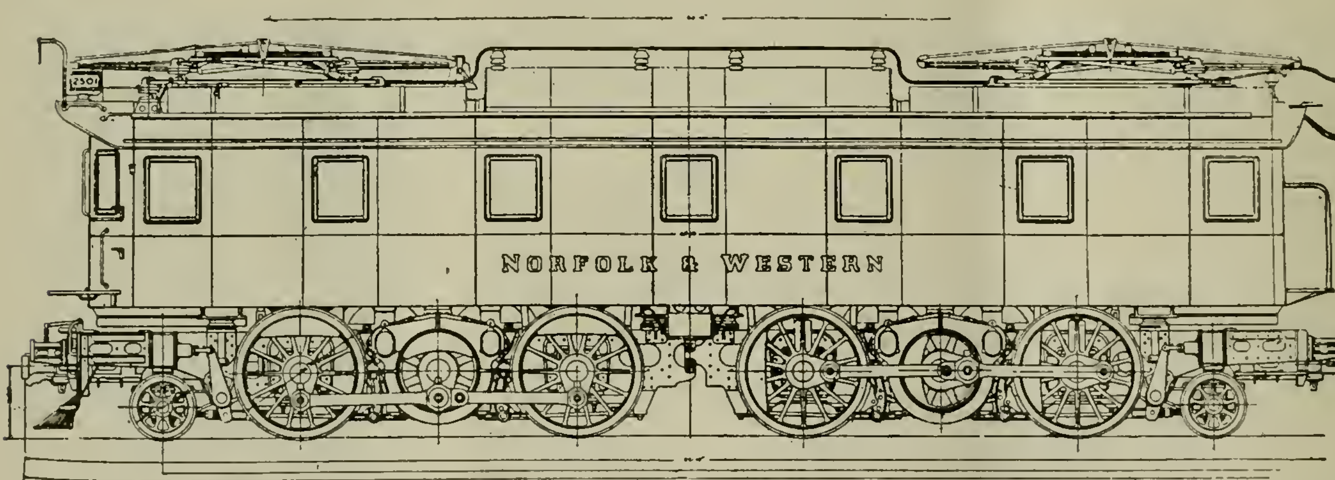
"It is really terrifying to realize that 25 per cent. of the total amount of coal which we are digging from the earth is burned to operate our steam railways—and burned under such inefficient conditions that an average of at least 6 lb. of coal is required per horsepower hour of work performed. The same amount of coal, burned in a modern central power station, would produce an equivalent of three times that amount of power in the motors of an electric locomotive, even including all the losses of generation and transmission from the power station to the locomotive."

Mr. Rice went on to say that 150,000,000 tons of coal, nearly 25 per cent. of all the coal mined in the United States, were consumed in steam locomotives last year. Here, in Canada, steam locomotives also did their bit and consumed about 9,000,000 tons; 30 per cent. of the 30,000,000 tons of coal imported into and mined in this country. Our 9,000,000 tons cover, I believe, wood and oil consumed on steam locomotives; some 49,000,000 gal. of oil are covered by the Canadian record. But in the United States figures, 40,000,000 barrels of oil (15 per cent. of the total output) are not included.

The conservation of—the elimination of the necessity for mining—those great quantities of fuel would be secured if all the railways were operated electrically, and if the electrical energy were generated from water power. Modern steam central stations would save from 50 to 66 per cent. of the coal now used in steam locomotives if the latter were discarded and electric locomotives used instead. With such possibilities for fuel conservation in sight may we not soon expect to learn that the fuel controllers in both countries have asked the railways, and that the railways' managers have asked their engineers: "How many of these millions of tons of coal can you save? When will the good work begin?"

It is said that our fuel shortages were due to a combination of bad weather and inadequate transportation. As we cannot control the weather, our attention and efforts must be directed to the transportation portion of the difficulty. Railway electrification will reduce coal consumption and haulage; it will also greatly improve traffic conditions. Electrification, therefore, seems to be the solution of the problem. Under these circumstances it may not be out of place to recite in general terms what electrification has actually accomplished on some notable railways. Railroading in the mountains is the most strenuous kind of railway work. The examples which I have chosen cover mountain sections. The Butte, Anaconda and Pacific Ry., by electrification, increased its ton mileage 35 per cent., and at the same time decreased the number of trains, and its incidenal expenses, 25 per cent. The time per trip was decreased 27 per cent. It is said the savings in the first year's operation, after electrification, amounted to 20 per cent. of the total cost of electrification. It buys power from water power plants.

On the Norfolk & Western Ry., power is obtained from its own steam station. Twelve electric locomotives have replaced 33 Mallets of the most modern and powerful type. The tonnage has been increased 50 per cent. Electrification obviated the necessity for double tracking. The salvage value of the released steam locomotives was 45 per cent. of the cost of electrification. Electric locomotives make eight times as many miles per train minute delay as the steam ones. Their terminal lay overs average 45 minutes and they are double crewed every 24 hours. Pusher locomotive crows have been reduced from 8 steam to 4 electric. Pusher locomotives have been reduced from 7 steam to 2 electric. Steam locomotives used to "fall down" in cold weather—the electrics always "stand up," and are really more efficient in cold weather. At the New York Railroad Club meeting last year the N. & W. electrical engineer stated that "coal wharves, spark pits, water tanks and pumps, as well as roundhouses and turntables, have all disappeared from the electric zone. The track capacity has been doubled. The operating costs have been reduced. From an engineering, and operating and a financial viewpoint the electrification has been a success." Speaking of the value of the regenerative electric braking of the system, he went on to say: "The use of the air brake is practically eliminated; it is only used to stop trains. It is regrettable we are unable to put a dollars and cents value on this great asset; to appreciate it



ELEVATION VIEW OF ELECTRIC LOCOMOTIVE, NORFOLK & WESTERN RAILWAY.

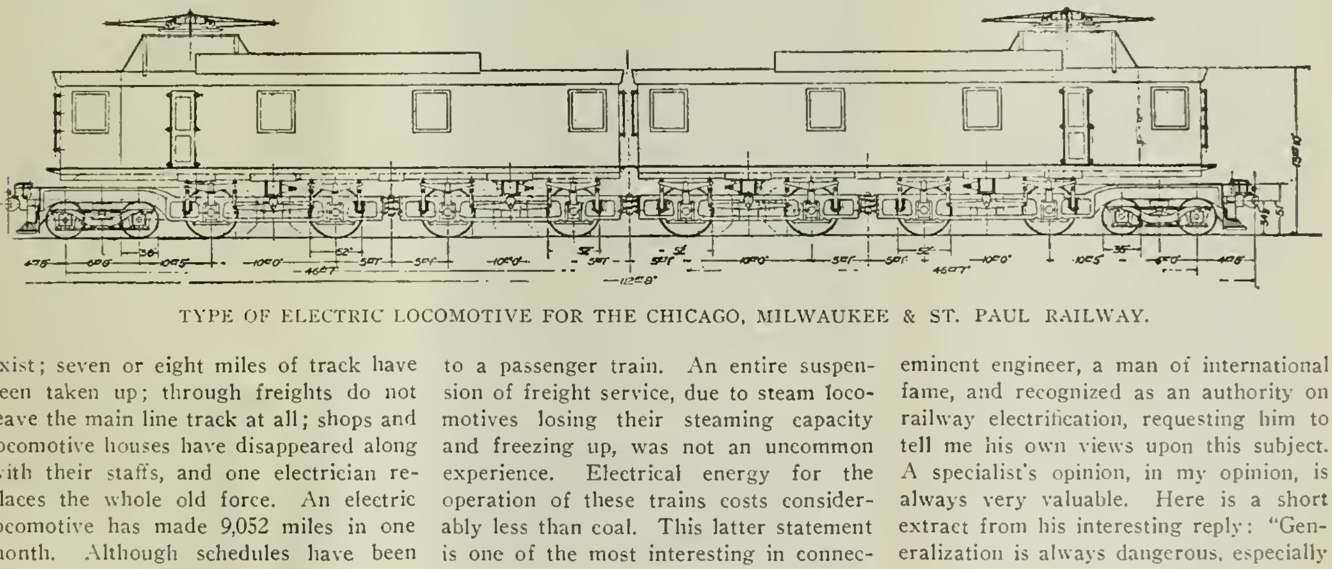
properly, one must have had experience with the difficulties of handling 90-car trains with air." Another official, referring to the same subject, made the following statement: The 2.4 per cent. grade, without ever touching the summit 12 to 20 times every day, down the 2.4 per cent. grade, without ever touching the air. We never broke a train in two or slid a wheel. It is done so nicely we wouldn't spill a drop of water out of a glass in the caboose."

The 440 route miles of the Chicago, Milwaukee & St. Paul Ry. which have been electrified will soon be augmented by 450 miles more. Nearly 900 route miles and about 33 per cent. in addition for passing tracks, yards, industrial tracks and sidings will soon represent the extent of this great railway electrification. Among the advantages secured by this railway on its electric sections are the following: The cruising radius of each electric locomotive is twice that of the steam locomotive. Subdivisional points, where freight crews and steam locomotives were formerly changed, have been abolished; the passenger crews' runs are now 220 miles, instead of 110. For railway purposes, these stations do not now exist; seven or eight miles of track have been taken up; through freights do not leave the main line track at all; shops and locomotive houses have disappeared along with their staffs, and one electrician replaces the whole old force. An electric locomotive has made 9,052 miles in one month. Although schedules have been reduced, the electrics have made up more than two and a half times as many minutes as steam locomotives—time which had been lost on other divisions; 29 per cent. of electric passenger trains made up time in this manner. On a mileage basis alone, the operating costs of the electrics are less than one-half the steam locomotive costs. Freight traffic increased 40 per cent. shortly after electrification—double tracking would have been necessary to handle such increased business under steam operation. An average increase of 22 per cent. in freight tonnage per train has taken place. One electric handles about three and a half times as many ton-miles as a steam locomotive; the reduction in times in handling a ton-mile is 30 per cent.; faster and heavier trains have accomplished these results, the number of trains has not been increased. About 11½ per cent. of the energy used by the railway is returned to the line in the process of regenerative braking and this returned energy helps to haul other trains. While this is a very important item and reduces the power bills, it is only regarded by the management as of secondary importance in comparison with the more safe and easy operation of trains on the grades and the elimination of former delays for changing brake shoes and repairs to brake rigging, when operating with steam locomotives. The electrics maintain their schedules much better than steam locomotives. In three months the electrics only waited for the right of way 254 minutes, while the steam locomotives in a similar period waited 1,910 minutes, or seven and a half times as long. Extra cars on trains only delayed electric one-ninth of the time steam trains were delayed for a similar reason. Cold weather delayed steam trains 445 minutes in the three months under discussion, but the electrics were not delayed a minute; the latter are more efficient in cold weather. Many of the delayed steam trains were double headers —never more than one electric is hitched to a passenger train. An entire suspension of freight service, due to steam locomotives losing their steaming capacity and freezing up, was not an uncommon experience. Electrical energy for the operation of these trains costs considerably less than coal. This latter statement is one of the most interesting in connection with the operation of the C., M. & St. P. Ry. and it is especially interesting because it was made more than a year ago. The foregoing experience of men who are actually operating large railway electrification projects, show what the electric locomotive is doing every day. As the vice-president of the last-mentioned railway said, "Electrification has made us forget that there is a continental divide."

The continual increasing cost of coal and fuel oil will force railway managers to look more and more carefully into railway electrification. Estimates of a few years ago now need revision. Money may be hard to get, but if, at times, fuel cannot be obtained at all, some substitute must be obtained if normal life is to be continued in northern latitudes. A representative of the National City Bank of New York, writing of the period after the war, referred to the stagnation which may ensue in all the great industries now engaged in war work as soon as peace is declared; the multitude of people thus thrown out of work, in addition to the men of the returning armies, would create unbearable conditions unless suitable employment will have been arranged for them in advance. He referred to the economic advantages of railway electrification and was of opinion that this work might solve the whole question if soon taken up with vigor.

The Minister of Public Works, Hon. F. B. Carvell, addressing the Canadian Society of Civil Engineers, Ottawa branch, recently, spoke of the necessity of conserving the energy of our water powers, instead of letting them run to waste, so that this great store of energy might be employed in assisting to build up our own and rebuild other countries when peace comes. How nicely these two ideals, water power development and railway electrification, work together if properly carried out.

With the view of securing something really worthy of presentation to this important meeting, I wrote recently to an eminent engineer, a man of international fame, and recognized as an authority on railway electrification, requesting him to tell me his own views upon this subject. A specialist's opinion, in my opinion, is always very valuable. Here is a short extract from his interesting reply: "Generalization is always dangerous, especially in connection with electrification of railways, where so many factors, such as the physical location, character of loads, the power situation, etc., come in to affect the decision if applied locally." From his sober statement it may be seen that my correspondent is an engineer, not a politician. He proceeded, as follows: "And with present equipment prices, the cost is absolutely prohibitive." This opinion, let me point out, is in connection with the proposal to "electrify everything." Do not let it dampen our enthusiasm. Listen to this also and kindly keep it in mind; it is another extract from the address of E. W. Rice, above referred to. He said: "I think we can demonstrate that there is no other way known to us by which the railway problem facing the country can be as



TYPE OF ELECTRIC LOCOMOTIVE FOR THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

quickly and as cheaply solved as by electrification."

While the present fuel shortage questions have made us look to railway electrification for relief, I feel such a project on a large scale can only follow or go hand in hand with power plant development and co-operative operation of power plants. The location of a number of plants at different points—large water power plants and auxiliary steam plants—so situated and inter connected that a failure at one plant or the connections to it will not jeopardize the others or completely cut off and isolate an important railway district is, in my opinion, an essential feature in connection with any large railway electrification project.

The 99-year contract of the Chicago, Milwaukee & St. Paul Ry. is worthy of more than a moment's attention and consideration in this discussion. That railway has a contract with a power company which has a series of plants stretching across the country parallel to the railway. The railway owns its sub-stations and secondary lines, but is not concerned with the power company's high tension lines or power plants. A reasonable rate for power, arranged between a willing purchaser and a willing seller—a contract, in fact, which each party knows the other will respect—is the basis and the real reason for that great railway electrification. Neither party questions the other's integrity or financial soundness. One delivers the power it has undertaken to supply and the other uses it. The arrangement is ideal in its simplicity and entirely satisfactory to everybody concerned. It will, in my opinion, be necessary to have such attractive power supply situations as those outlined above, backed by abundant supplies of power, in order to foster and encourage early railway electrification work in this country. Railway electrification is, in my opinion, a very pressing financial, economic and engineering problem—a problem worthy of the best attention of the most highly trained and experienced specialists.

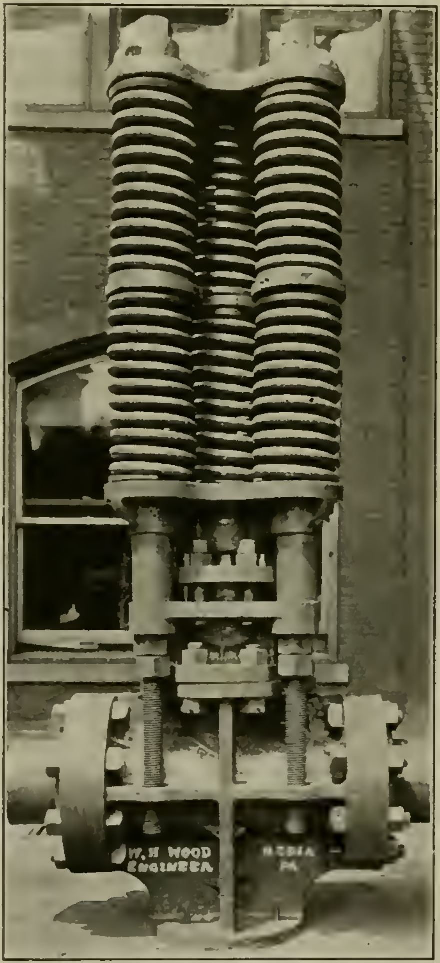
Elements of Combustion.

One of the most perplexing problems that has always been present with steam-men and especially with railroad men has been, how can bituminous coal be burned without causing smoke nuisance? It is well known to every observer that when fresh coals are placed on a fire in an open fire-grate, smoke arises immediately, and the cause of that smoke is not very far to seek, as it will be easily understood that before the fresh coals were put upon the fire within the grate, the glowing coals already burning have been radiating their heat and warming the air above, thereby enabling the rising gases to combine with the warmed air to produce combustion, but fresh coal absorbs heat and cools the gases.

Powerful Hydraulic Shock Valve

The function of a shock valve is to release the excess pressure that may be caused by the sudden drop of the accumulator or by a sudden release of pressure caused by accident. This drop of accumulator will raise the pressure from 300 to 500 lbs. above the regular working pressure, which in this case is 1,500 lbs.

The five double springs hold down the 6 ins. plunger of the valve at 1,500 lbs. and for every 100 lbs. of excess pressure, the 6 ins, plunger will compress the springs 10 ins., thus relieving the shock



HYDRAULIC SHOCK VALVE.

by making a displacement in the pipe equal to the area of the plunger which is 28¼ ins. No water is released from the pressure pipes to which it is attached, and which are 8 ins. in diameter. From face to face of connecting flanges of the valve it is about 33 ins. and the height over all 6 ft. 3 ins., that is, from base to top of springs, and the valve is about 26 ins. wide, that is over the springs. The foot is put on valve to relieve the weight of valve from the pressure mains. A concrete pier can be built under it, and a plate with a couple of steel rollers can be placed under it to allow for the expansion and contraction in the pressure pipes to which it is attached.

This is said to be the largest valve that has been made for this purpose, and will be used in the Ordnance Department of the New York Air Brake Company at Watertown, N. Y., and has been constructed by William H. Wood, the well-known builder of special machinery, at his engineering works, Reading, Pa.

Improving the Locomotive.

A great many mechanics, and people connected with the mechanic arts, turn their attention to improving the appliances in use, and much ingenious labor is wasted in this line because the would-be inventors are ignorant of what has been tried and failed and what has succeeded. We would particularly advise inventors to study from records of past achievements to find out how much of their ingenuity has been tried by former inventors.

It is no doubt possible to improve the appliances used to promote combustion in locomotive fire-boxes so that more efficiency may be effected by the fuel burned, and we notice that such subjects are receiving considerable attention at the present time.

When talking some time ago with a retired master mechanic of the Pennsylvania Railroad we heard interesting reminiscences of what had been done to promote combustion in locomotive fire-boxes when coal was first introduced as fuel. Among the devices tried the combustion chamber was a favorite, and it was made between 4 ft. to 5 ft. long, but what astonished the mechanical man was that when the space used by the combustion chamber was filled with tubes the engines always steamed better. Various methods of mixing air with the flames were tried, brick arches in different forms were applied, and their only utility was to help the fireman to prevent smoke.

A Curious Accident.

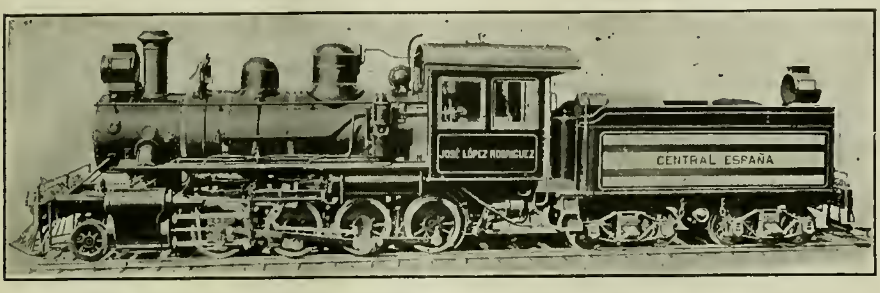
Some engineers delight to take a rise out of reporters who crowd round to tell the cause of breakdowns of passenger trains. Jim Benin is a good engineer, who thinks that men who provide news for newspapers are a nuisance and deserve no consideration.

Jim had a broken valve stem the other day, and a reporter turned up to find out the cause of delay. Jim said: "Now don't go and get this thing mixed up and make me ridiculous. Give the plain facts and nothing else. This accident is not uncommon on fast trains. All there is to it is 'that the Jeemis pin came out of the ash-pan and the engine won't suck her ashes."

Superheaters on Small Locomotives

The superheater is now recognized as an essential part of American locomotives. Practically all of the locomotives built in the past few years for American roads are superheated. Indeed, in the case of much of our larger power it would be impossible to obtain satisfactory results if the superheater were not employed. There is no limit placed on the size of the locomotive to which superheaters are applicable. The huge Mallets of the 2-10-10-2 type, recently built for the Virginia Railway by the American Locomotive Company are of necessity equipped with superheaters; and, going to the other extreme, many plantation owners and logging companies, recognizing the increased capacity and economy resulting from the use of superheated steam, have equipped their locomotives with this device. A recent example of the use of superheaters in plantation locomotives is the small Consolidation shown in our illustration. Two of these locomotives were recently built by the Vulcan Iron Works, Wilkes-Barre, Pa., for the Central Espana Plantations, and are now operating in San Domingo.

These engines burn soft coal and have cylinders 15 ins. in diameter by 20 ins. in stroke. The driving wheels are 37 ins. in diameter, and with a boiler pressure of 170 lbs., the locomotives will develop 17,600 lbs, tractive effort. The boiler is of the straight top type, 48 ins. inside diameter at the first ring, and contains a 12-unit superheater, type A, supplied by the Locomotive Superheater Company, 30 Church street, New York. There are twelve 5⅜ ins. flues and seventy-nine 2 in. tubes, 11 ft. 3 ins. long over tube sheets. The heating surface of the tubes and flues is 650 sq. ft. and that of the firebox 65 sq. ft., making a total evaporative surface of 715 sq. ft. The superheating surface is 150 sq. ft., and the grate area is 17.5 sq. ft. As will be seen from the engraving, the locomotives are modern in every respect, having Westinghouse air brakes, electric headlights and Walschaerts valve gear. They weigh, in working order, 79,000 lbs., of which 69,000 lbs. is on the drivers.



SMALL 2-8-0 WITH SUPERHEATER FOR THE CENTRAL OF SPAIN.

Compound Mallet for the N. & W.

A number of large compound engines of the Mallet type (2-8-8-2) called on the road Y-2 class, have recently been built by the Norfolk & Western Railway at their own shops at Roanoke, Va., according to designs approved by Mr. W. H. Lewis, superintendent of motive power. These engines have a tractive power of 104,350 lbs., and carry a steam pressure of 230 lbs. The grate area is 96 sq. ft, and the heating surface is 7,850 sq. ft., including firebox and flues.

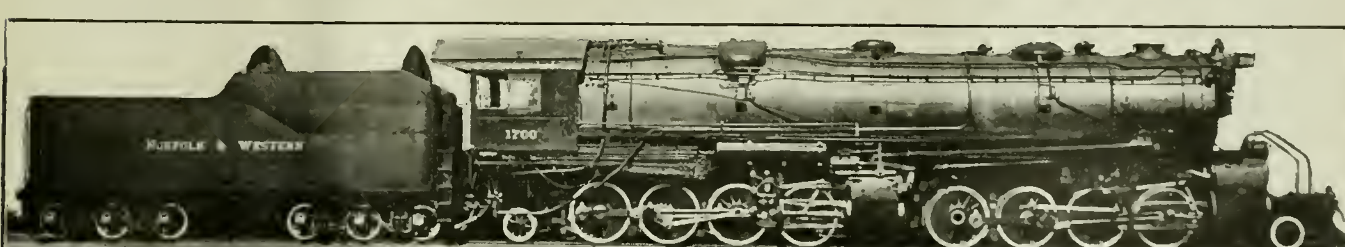
The cylinders of these engines are, H.P. 39 x 32 ins. and the L.P. 24½ x 32 ins. The main valves are of the piston type and are 17 and 14 ins. respectively. The spread of the engine truck and the rear carrying wheels is 57 ft. 4 ins., and the weights within this length are, 35,000 lbs. on the rear carrying wheels, 23,600 lbs. on the set of eight rear driving wheels, 23,600 lbs. on the front set of drivers, and 28,000 lbs. on the engine truck wheels, making a total weight for the engine, in working order of 535,060 lbs. The weight carried upon the sixteen driving wheels is 472,000 lbs.

The overall length of the engine is 66 feet. 6 ins., while the drivers are confined to a space of 42 ft. 1 in. The tender over-all length is 35 ft. 4⅛ ins., and weighs in working order 212,000 lbs. It is mounted on two six-wheel trucks, having an extreme spread of 28 ft. 6¾ ins.

The boiler is of the wagon top type and the slope of the gusset sheet just behind the dome to the firebox is 2 11/16 ins. The outside diameter of the boiler is 98 ins. The boiler sheets are 1 1/16, 1⅛ and 1 in. thick. The breakage zone is fitted with flexible stay-bolts. The extreme height to the underside of the roof of the cab to the rail is 15 ft. 7 ins. and other parts of the engine are less than this. Over the smoke stack the height is 15 ft. 5⅝ ins. The height over the balance ball on top of the bell is 15 ft. 9 ins., so that this figure is the practical limit of height for the engine, and it will get through under anything over this figure. Some of the specialties used on the locomotive are given below. They are equipped with the following specialties:

Baker Valve Gear, Schmidt Superheater, Chambers Throttle, Sentinel Low Water Alarm, Graham-White Perfect Sanders, Duplex Stokers, Sellers Injectors, American Brake Company's Foundation Brake Gear, McCord Force Feed Lubricator, Pyle National Headlight Generator.

The sample locomotive of this class is already in use, and the service of same has been found to be very satisfactory. The dimensions are as follows: Fire box—Length, 144 ins.; width, 96 ins. Tubes—Number, 2¼ 287 ins., 5½ 53 ins.; diameter, 2¼ and 5½ ins.; length 24 ft.; heating surface—total, 7,850 sq. ft.; Ratios: Weight on drivers ÷ tractive effort = 4.52; heating surface ÷ grate area = 78; weight on drivers ÷ heating surface = 63; total weight ÷ heating grate area, 96 sq. ft. Driving wheels—Diameter outside, 56 ins.; diameter center, 50 ins.; journals, 11 x 12 ins. Wheel base—Driving, 42 ft. 1 in.; rigid, 15 ft. 6 ins. Total engine, 57 ft. 4 ins. Total engine and tender, 92 ft. 11¼ ins. Superheater—Type A Stokers—Duplex.



MALLET COMPOUND FOR THE NORFOLK & WESTERN RAILWAY.

W. H. Lewis, Supt. Motive Power. N. & W. Builders.

Electrical Department

Torque of Electric Motors as Applied to Electric Locomotives—Axle Generators for St. Paul Locomotives

The last issue contained a short description of "The Torque of a Motor." It seems that this is a rather important subject. There are many questions that immediately arise. What is the torque? What is the formula for calculating it? Why is the pull or twisting moment taken at one foot radius? Does the torque vary? Is it different for different types or classes of electric motors—namely the series motor, the shunt motor and the induction motor? How does it affect the tractive effort of the electric locomotive? To better understand the relation of torque, we will first make a comparison between the steam and electric locomotive showing how this torque enters into the rating of the electric locomotive. Later, we will consider the individual torque characteristics of the three different types of motor mentioned above.

In the case of the steam locomotive, the power and tractive effort can be easily calculated, as all factors are concrete and mechanical and known. Is there a similar concrete arrangement for the electric motor? The power of the steam locomotive is generally expressed in the term of tractive effort and the T. can be easily calculated from the formula

$$T = \frac{C^2 \times S \times .85\ P}{D}$$

Where

T = tractive force at rim of driving wheels.

P = usually 85 per cent. of the boiler pressure in pounds per square inch.

C = diameter of cylinders in inches.

S = stroke in inches.

D = diameter of driving wheels in inches.

The power of the electric locomotive is also expressed in terms of tractive effort and same can be determined if we know the number of motors mounted on the running gear and the electrical characteristics of each motor. The only fixed concrete part which enters into the calculation of the tractive effort is the wheel diameter. The force from the motors is not dependent upon quantities, such as boiler pressure or the fixed, diameter of cylinder and length of stroke, but upon the electrical characteristics which vary with the amount of current taken by the motor.

The steam locomotive consists of two distinct parts, the boiler and the engine, each designed for the service in which the locomotive is to be placed. The boiler has its limits in size and it is necessary to work the boiler at its maximum capacity so as to get the most power possible out of the locomotive. The engine is distinct from the boiler and the power it is capable of delivering in the terms of tractive effort at the drivers is determined by the above-mentioned formula.

It will be seen from reference to the formula that the only variable part is the boiler pressure, so that with full boiler pressure in the cylinders the maximum tractive effort is obtained.

The electric locomotive does not have two distinct parts. The boiler is at the power house, which may be several miles away. The power for operating the locomotive is brought to it over wires or some such conductor, and connected to the electric motors. The motors are connected to the driving-wheels and the locomotive delivers power in the form of tractive effort just as the steam locomotives does.

The tractive effort of the electric locomotive depends on the number of motors that are connected to the driving wheels. As these motors are generally all the same, the total power is a multiple of what one motor is capable of doing. The power of the motor is the force it has to rotate, and for convenience has been reduced to the pull in pounds is can exert on one foot radius from the centre of the armature shaft—that is at any point in a circumference of a circle of 24 ins. diameter whose centre is at the centre of the shaft. The distance of one foot and the pull expressed in pounds, is most convenient as the turning power expressed in foot-pounds which is a recognized unit, 550 of which per second is equivalent to one horsepower.

As mentioned above, the tractive effort of the electric locomotive depends on the number of motors which may be connected to the driving wheels. The formula for an electric locomotive then, is as follows:

$$T.\ E. = \frac{T \times 24 \times G \times \text{gear eff.} \times N}{D \times g}$$

Where T. E. = tractive effort.

T = torque of motor.

G = number of teeth in gear.

D = diameter of driving wheel in inches.

g = number of teeth in pinion.

N = number of motors.

This is a general formula to take care of all conditions. In many designs of locomotives the motor is direct connected to the driving wheels and in this case, the factors G and g and the gear efficiency drop out. The torque of the motors produce the tractive effort and the relation between them is determined by the transmission. If gearing is used, the speed of the car axle is changed from that of the motor shaft by the ratio of g to G, and as the power at the motor shaft and axle are practically the same, the torque at the axle must increase and by the ratio of G to g. Since the torque is measured at one foot radius and the tractive effort is measured at the wheel tread the T. E. will be to the torque as 24 is to D.

Referring to the formula all the factors are fixed except the torque and this is the factor we are much interested in.

The torque of the motor is entirely different from the power obtained in the steam cylinder, in that the value depends on the amount and not on the pressure. The amount of current to the motor is at the control of the engineer, so that within safety limits as large a torque as desired can be obtained from the motors and the maximum power is not fixed as in an engine supplied with constant steam pressure. There is a certain relation between the current taken by the motor and the torque delivered, but for practical purposes there is no formula to say what this Torque is. Electrical designers, knowing the number of turns of wire on the armature, the number of turns of wire around the field poles, the air gap and many other factors in the design of the motor could calculate the torque. This laborious process is not practical and moreover the details of design are not generally available.

In order, therefore, that the T. E. can be calculated and the performance of the electric locomotive be known, the designers furnish, with a motor, a set of curves obtained by tests known as the characteristic curves. These characteristic curves show the relation between current, torque and revolutions, and it is possible, knowing one to obtain values for the others.

Before taking up in detail these characteristic curves and showing how to read them, we will consider further the comparison of the steam and the electric locomotive. The torque and hence the T. E. depends on the amount of current flowing through the motors which is under the control of the engineer. There is, as far as one locomotive is concerned, an unlimited supply of power available

and the maximum power is not fixed as with the steam locomotive. It is therefore possible with the electric locomotives to take advantage of extra adhesion with the rail, which may be natural or caused by application of sand. A coefficient of adhesion as high as 33 per cent. has been obtained. It is then a matter of having sufficient wheel load on drivers to take care of maximum drawbar pull required.

While the electric locomotive has this great advantage of being able to exert a large maximum tractive effort, it is not possible to maintain this tractive effort continuously, on account of the damage which would result to the motors. This takes us to what is meant as the continuous and hourly rating of an electric locomotive which does not enter into the calculation where the steam locomotive is used, as the latter is able to maintain its maximum tractive effort at slow speed as long as desired.

Since the torque depends on the amount of current passing through the motor, with this very large torque an equally large current is required, which passes through the armature and field coils. These coils are made up of copper wires or bars, covered with special tape or insulation, and have a certain resistance to the flow of the electric current. This resistance causes heat to be generated, which is conducted away by the iron and by radiation, and a certain constant temperature will be reached when a certain constant current is flowing through the motor continuously. There is a maximum temperature of about 70 degs. C. above that of the surrounding air which the motor should not exceed, for if this is exceeded, the excess temperature will damage the insulation around the coils and later cause a failure of the motor. If this excess current is allowed to remain on too long the motor would become so heated that it would burn up. The value of the current which will give this maximum rise above the air determines the torque each motor can exert continuously and thus the tractive effort and drawbar pull of the locomotive.

We have taken the case where the maximum temperature is reached with continuous current. A very much larger current can be taken for a certain period before the maximum allowable temperature is reached without harm to the motors, and so it is possible to rate the motors at a much larger torque for a short time performance. It is customary to take one hour, and so with the same locomotive we are able to obtain much greater tractive effort, but the locomotive is not able to exert this tractive effort continuously or undue heating of the motors would result.

It is now clear why it is possible to get a large tractive effort for starting or emergency conditions and why this same tractive effort cannot be used continuously. In specifying an electric locomotive, the work this locomotive will have to do is studied carefully, and then it is fitted with motors of such size that the work in any one hour will not cause overheating. It is possible to work these motors for short periods at much higher currents, but it will be necessary to have coasts, stops or layovers so that the total amount of current in any one hour will not exceed the safe value of the motors. This is of vital importance in the operation of the electric locomotive, but does not concern the steam locomotive runner, for as long as the boiler has plenty of water no harm can be done by operating it continuously at its maximum drawbar pull.

It is seen clearly from the above comparison that the motor characteristics must be available before the performance of an electric locomotive can be known. These characteristic curves show the relation between the current taken by the motor, the torque developed and the revolutions. With the voltage constant the torque and the revolutions are always the same for the same current; in other words, there is a definite relation between them. The types of motors used today for electric locomotives are the direct-current series motor, the alternating current single-phase motor and the three-phase motor. The alternating current motor can be divided into the straight series type and the doubly-fed type, both of the series motor-speed characteristics like the direct-current series motor.

The series motor is generally used, since its characteristics in nearly every case better meet operating conditions. There are service conditions, such as are encountered on the Norfolk & Western Railroad, where the constant-speed three-phase motor works out advantageously. Due to the variation in grades and curves, the tractive effort required to propel a train over the road varies. When running up grades and around curves a larger tractive effort is required than when running on a straight and level track. When accelerating a train, a still larger tractive effort is required, and when running at full speed only enough tractive effort is required to overcome the train resistance. We know that in the series motor the field and the armature are in series, so that as the load increases the current increases and the field increases. We know also that as the field strength increases, the torque or pull of the motor increases and the speed decreases.

The torque depends on two factors—the ampere turns in the armature and the field strength. Each varies directly with the current, so that in an unsaturated motor the torque is proportional to the square of the current. Motors used for railway work are generally more or less saturated, so that the exact proportion does not hold.

In the case of the three-phase motor the speed is constant, depending on the frequency of the power supply and not on the current. The torque is, then, nearly directly proportional to the current. The speed cannot decrease with the load, so that large torque may exist at high speed, resulting in a large horsepower output and requiring a large imput of power.

It is the general practice to draw up a set of characteristic curves for the complete locomotive so that it is possible to read off the relation existing between the speed in miles per hour, the tractive effort in pounds and the current taken. In other words, the pounds tractive effort is obtained by multiplying the torque of the motor by N (the number of motors) $\times \frac{G}{g} \times \frac{24}{D} \times$ gear efficiency. The miles per hour is obtained by multiplying the r. p. m. $\times D \times \frac{g}{G} \div 336$.

(To be continued.)

Axle Generators for St. Paul Locomotives.

One of the novel features used on the Baldwin Westinghouse locomotives being built for the heavy passenger service of the Chicago, Milwaukee & St. Paul Railway, is the axle-driven generator. There are two of these generators, each one being mounted on the trailing axle of the four-wheel guiding trucks. The generators are mounted and geared to the axle in the same way as the ordinary street car motor. From outside observation, they look like small sized railway motors. However, their purposes are entirely different. The axle-driven generators are used entirely for generating current, and they form not only a source of excitation for the fields of the main motors during operation, but they are of the source of power for the auxiliary motors, such as compressors and blowers, during the remainder of the running time. The generators are regulated for a normal voltage of 100, and it is regulated for this during the period that they are furnishing current for the auxiliary motors. During the period of regeneration the voltage of the machine varies from 25 to 100 volts. The generator fields are excited from a storage battery circuit, and the voltage is controlled by a power-operated rheostat automatically controlled during the time the machine furnishes current for the auxiliary motors, and manually controlled by the engineer during the time when the locomotive is occupied in the act of regenerating which is an advantage.

Superheater Used on Rotary Snow Plow Engine

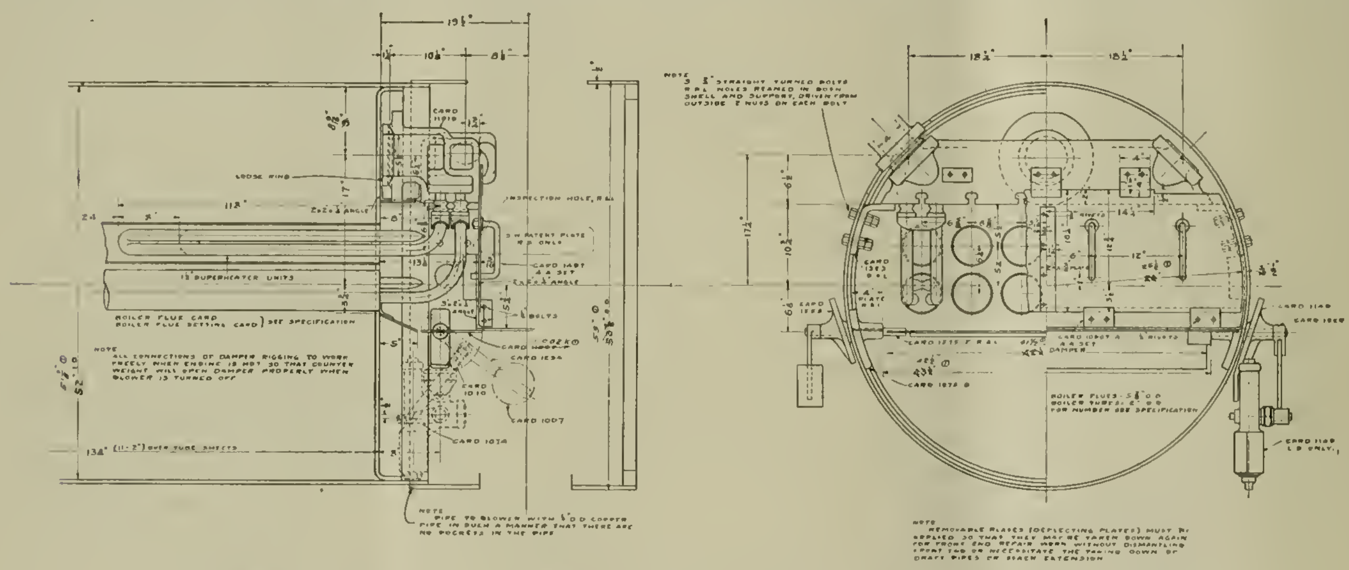
Rotary snow plows are very generally used in districts where the winter conditions are severe. After heavy snow storms on roads in mountainous regions these plows have to be worked to their maximum capacity, and frequently have to maintain this rate of working for long periods of time. Any means of increasing the power of a rotary plow adds to the facility and speed with which the road can be cleared of snow and also reduces the danger of the plow becoming snowed in or stalled in a drift.

The use of highly superheated steam in rotary snow plows provides a substantial increase in the power of the plow and also reduces the fuel and water consumption, so that the danger of running out of fuel and water at some point where an additional supply cannot readily be obtained is considerably lessened. In a recent example of the application of superheaters to a rotary snow plow on a Western road, the operating results obtained showed very plainly the advantages over a plow using saturated steam.

The snow plow service on this railroad is probably more severe than anywhere else in the country, outside of Alaska. It is necessary to use plows throughout nine months of the year, beginning about the middle of September, and in order to keep the road open in the face of the numerous heavy snow storms, the plows must be operated at maximum capacity for considerable periods of time. The operating officials have been highly gratified with the results of superheating this plow and report that it is more economical on coal and water than a plow using saturated steam is, because it can be operated indefinitely at full capacity. It has established its superiority over plows using saturated steam in the prompt and effective clearing of the road.

This plow is equipped with a Type A superheater furnished by the Locomotive Superheater Company, 30 Church street, New York, N. Y. The arrangement of the superheater, which is shown on our drawing, is similar to that employed on locomotives. The boiler is 11 ft. 2 ins. long over tube sheets and the superheater units, of which there are twelve, extend to within 24 ins. of the back tube sheet. The header is of the tee-bolt type.

While the conditions on the entire district over which this plow is operating are very severe, the most difficult portion of the road is at the end of a snow shed on a 4 per cent. grade. At this point the altitude is over 11,600 ft.



THE LOCOMOTIVE SUPERHEATER COMPANY'S DEVICE APPLIED TO A ROTARY SNOW PLOW ENGINE.

Diversity of Motive Power.

One of the advantages hinted at in the Government control of railroads is that there is likely to be more uniformity in the design of the power employed. It has been our privilege to visit a great many establishments belonging to railroads in various parts of the continent, and we have often marvelled at the practices and products encountered.

An eminent British contemporary once put before its readers questions concerning the causes for the diversity of the motive power on different railways. Such questions as the following were asked: Why have express locomotives on some lines inside cylinders while others on the same line are outside? Why do some engines have coupled wheels while others are single? Why do some engines have domes while others take the steam from a perforated pipe? Why does the heating surface range from 1,000 to 1,500 sq. ft. There were many questions that did not apply to American locomotives, but questions might be formed that would take cognizance of the diversity of our motive power, the only rational explanation for the diversity being many men, many minds.

If radical difference in practice made no difference in the expense of operation, onlookers and those financially interested might be contented to regard the preferences of different men with some indifference; but it is nearly always in diversity of design that there is evidence of good and bad, and the choosing of the bad implies that increased expense has been incurred in obtaining required results. When this is the case the error of judgment, which leads to faulty design or to the choice of unsuitable material.

We have heard such questions asked, as why some master mechanics prefer straight boilers or forms that provide limited steam room, when the wagon top is the recognized form of the Master Mechanics' Association? Some critics ask, is there any necessity for making expensive butt joints for boiler seams when lap joints have been found perfectly reliable? Why do some designers stay the crown sheet by means of radial stays when others use crown bars? Why are the locomotives for some roads built with the mud ring above the frame, while the common practice is to make a cheap, narrow firebox? Is there good reason for the practice of some roads using a brick arch while other roads using the same quality of coal doing similar work find a plain firebox satisfactory? Common practice makes the length of cylinder steam ports about the length of cylinder diameter, yet of some are shorter.

Items of Personal Interest

Mr. J. F. Murphy has been appointed general manager of the Missouri Pacific, with headquarters at St. Louis, Mo.

Mr. J. Hay has been appointed master mechanic of the Grand Trunk Lines in New England, with office at Portland, Me.

Mr. L. E. Fletcher has been appointed master mechanic of the Santa Fe, with office at Raton, N. M., succeeding Mr. I. A. Conley.

Mr. B. P. Phillippe has been appointed fuel distributor of the Central Advisory Purchasing Committee, with headquarters at Washington, D. C.

Mr. J. A. Klumb, formerly master mechanic of the Chicago, Milwaukee & St. Paul, has been transferred from Milwaukee to Madison, Wis.

Mr. H. G. Huber has been appointed assistant superintendent of motive power of the Pennsylvania, Pittsburgh division, with office at Pittsburgh, Pa.

Mr. L. M. Jones, formerly assistant to the general manager of the Norfolk Southern, with office at Norfolk, Va., has been appointed purchasing agent.

Mr. J. H. Garden, formerly master mechanic of the Grand Trunk at Battle Creek, Mich., has been appointed master mechanic at Stratford, Ont., Canada.

Mr. A. G. Pack, whose name was placed in nomination for the position of inspectoru of locomotives by President Wilson, was confirmed by the Senate last month.

Mr. M. J. McCarthy, formerly superintendent of motive power of the Baltimore & Ohio, has been appointed superintendent of equipment, western lines, with office at Cincinnati.

Mr. L. G. Curtis, formerly assistant chief engineer of the Baltimore & Ohio, with office at Baltimore, Md., has been made chief engineer of the western lines, with office at Cincinnati, Ohio.

Mr. C. A. Kothe, formerly master mechanic of the Erie, with office at Port Jervis, N. Y., has been transferred to a similar position on the same road, with office at Brier Hills, Youngstown, O.

Mr. C. C. Higgins, formerly assistant to the vice-president of the 'Frisco lines, has been placed in charge of the mechanical department, succeeding Mr. P. T. Dunlap, granted leave of absence.

Mr. F. G. Grimshaw, formerly superintendent of motive power of the Pennsylvania, with office at New York, has been appointed assistant to the general manager, with office at Philadelphia, Pa.

Mr. H. A. Kennedy has been appointed manager of the St. Paul and Minneapolis terminals, including Minnesota transfer for the United States Railroad Administration, with headquarters at Washington, D. C.

Mr. E. A. Hadley, formerly chief engineer of the Missouri Pacific, with headquarters at St. Louis, Mo., is now engineering assistant to the regional director of southwestern railroads, with office at St. Louis.

Mr. A. S. McKelligan, formerly storekeeper of the Southern Pacific, at Sacramento, Cal., has been appointed general storekeeper with headquarters at San Francisco, Cal., succeeding Mr. H. G. Cook, resigned.

Mr. W. J. Burkhart has been appointed roundhouse foreman of the Santa Fe, with office at Gallup, N. M., and Mr. S. M. McKean has been appointed to a similar position on the same road with office at Brownwood, Tex.

EDWARD P. RIPLEY.

Mr. G. E. Sisco, formerly master mechanic of the Pennsylvania lines west of Toledo, Ohio, has been appointed master mechanic of the Logansport division, with office at Logansport, Ind., succeeding Mr. O. C. Wright, promoted.

Mr. O. H. Wood, formerly assistant purchasing agent of the Great Northern at Seattle, Wash., has been appointed special representative of the Central Advisory Purchasing Committee of the Railroad Administration, with headquarters at Seattle.

Mr. J. T. Carroll, formerly general superintendent of motive power of the Baltimore & Ohio, has been appointed mechanical assistant on the staff of the Regional Director, Mr. Charles H. Markham, of the Allegheny Region, United States Railroad Administration.

Mr. C. Tillett, formerly supervisor of signals of the Grand Trunk, has been appointed electrical engineer, with headquarters at Montreal, Que., succeeding Mr. J. A. Burnett, who has been appointed technical assistant with the British War Mission at Washington, D. C.

Mr. C. H. Bilty, formerly mechanical engineer of the Pennsylvania Western Lines, southwest system, with office at Pittsburgh, Pa., has been appointed division engineer of the northwest system, with office at Fort Wayne, Ind., succeeding Mr. Guy Scott, who has joined the army.

Mr. C. A. Wheeler has been appointed master mechanic of the Quebec division of the Canadian Pacific, with office at Montreal, Que., succeeding Mr. John Burns, promoted, and Mr. J. S. Allen has been appointed master mechanic with office at Sunbury, Ark., succeeding Mr. Wheeler.

Mr. F. J. Monahan has been appointed master mechanic of the Birmingham division of the Louisville & Nashville, with office at the shops at Boyle, Ala., and Mr. T. H. Hogan has been appointed master mechanic of the Memphis line, with office at Paris, Tenn., succeeding Mr. Monahan.

Mr. A. N. Ostberg, formerly mechanical inspector of the Chicago, Burlington & Quincy, with headquarters at Chicago, Ill., has been appointed mechanical engineer for valuation, succeeding Mr. W. H. Davis, who has been appointed as office engineer in the department of inspection and tests of the railroad administration at Washington, D. C.

Mr. W. S. Galloway, formerly assistant purchasing agent of the Baltimore & Ohio at Baltimore, Md., has been appointed purchasing agent of the Baltimore & Ohio, eastern lines and New York terminals, the Western Maryland, the Cumberland Valley, the Cumberland & Pennsylvania, and the Coal & Coke, with office at Baltimore.

Mr. Robert Collett, formerly supervisor and superintendent of locomotive performance of the 'Frisco Lines and latterly assistant manager of the railroad department of the Pierce Oil Corporation, has been appointed assistant manager of the Fuel Conservation section of the United States Railroad Administration, eastern district, with headquarters at New York.

Mr. T. B. Farrington, formerly assistant master mechanic of the Pennsylvania Western Lines, southwestern system, with office at Columbus, Ohio, has been appointed master mechanic of the Michigan division, with office at Logansport, Ind., succeeding Mr. J. R. Riggs, who has been appointed master mechanic on the central system, Toledo division, with office at Toledo, Ohio.

Mr. Martin H. Clapp, formerly super-

intendent of telegraph of the Northern Pacific, has been appointed manager, telegraph section, division of operation of the Railroad Administration, with office in the Southern Railway building, Washington, D. C. Mr. Clapp will have supervision over telegraph and telephone lines in connection with the railroads under Federal management.

Mr. R. W. Anderson, formerly division master mechanic of the Chicago, Milwaukee & St. Paul at Niles City, Mont., has been appointed assistant superintendent of motive power of the middle district of the same road, with headquarters at the Milwaukee shops, Milwaukee, Wis., succeeding Mr. A. W. Lucas, who has been appointed shop superintendent, with jurisdiction over the locomotive department of the Milwaukee shops.

Mr. J. M. R. Fairbairn, formerly assistant chief engineer of the Canadian Pacific, with headquarters at Montreal, Que., has been appointed chief engineer of the Canadian Pacific. Mr. Fairbairn is a graduate of Toronto University and entered railroad service as a draughtsman on the Canadian Pacific at Winnipeg, Man. In 1911 he was appointed assistant chief engineer, which position he held until appointed chief engineer as above noted.

Mr. A. J. Vogler, formerly general foreman of the passenger terminal of the Chicago, Milwaukee & St. Paul, at Western avenue, Chicago, Ill., has been appointed master mechanic of the Sioux City & Dakota division of the same road, with office at Sioux City, Ia., and Mr. George P. Kempf has been appointed engineer of tests, with office at Milwaukee, Wis., succeeding Mr. K. Fox, who has been appointed mechanical engineer, with headquarters at Chicago.

Mr. J. E. Mechling, formerly master mechanic of the Pennsylvania lines west at Terre Haute, Ind., has been appointed superintendent of motive power of St. Louis system, with office at Terre Haute, and Mr. R. H. Flinn, formerly assistant engineer of motive power of the Central system, succeeds Mr. Mechling as master mechanic at Terre Haute, and Mr. C. W. Kinnear, formerly assistant master mechanic at Dennison, Ohio, succeeds Mr. Flinn as assistant engineer of motive power at Toledo.

Mr. E. J. Brennan, formerly general master mechanic of the Baltimore & Ohio, with office at Pittsburgh, Pa., has been appointed superintendent of motive power of the Chicago, Milwaukee & St. Paul lines east of Mobridge, with headquarters at Milwaukee, Wis., and Mr. W. F. Walsh, formerly traveling mechanical expert for the Galena Signal Oil Company, with headquarters at Chicago, has been appointed assistant superintendent of motive power of the southern district of the Chicago, Milwaukee & St. Paul, with headquarters at Dubuque, Iowa.

Mr. Edward P. Ripley, who has been president of the Atchison, Topeka & Santa Fe for the last twenty-two years, has resigned from his executive duties in connection with the operation of the road, but remains as president of the corporation in charge of the interests of the stock

GEORGE W. WILDIN.

and bond holders. Mr. Ripley has achieved an enviable reputation among the railroad men of America. He retires from the operation of the road with the genuine affection of all who have worked under him, and it is only justice to state that

CHARLES W. GALLOWAY.

under his management the road has developed in magnitude and efficiency in service in an unparalleled degree.

At a recent meeting of the Board of Directors, Mr. George W. Wildin was duly elected general manager of the Westinghouse Air Brake Company, vice Mr. A. L. Humphrey, resigned. Mr. Humphrey continues as ranking vice-president and in that capacity will, as heretofore, have general direction of the company's operations in all departments and subsidiary organizations, Mr. Wildin reporting to him. As general manager of the Locomotive Stoker Company, Mr. Wildin has been succeeded by Mr. D. F. Crawford, formerly general manager of the Pennsylvania Lines West, who was elected vice-president and general manager of the Stoker Company. At the same meeting of the Stoker Company, Mr. N. M. Lower was elected assistant general manager.

Mr. Charles W. Galloway, who has been appointed Federal Manager of the Baltimore & Ohio Western Lines, has had an experience of thirty-five years in the service of the road. Beginning as utility boy in a telegraph office at the age of fifteen, he has filled many positions and is a master of transportation, being superintendent of nearly all of the divisions of the road, and in 1912 was appointed general manager, which position he held when appointed Federal Manager. It is interesting to recall that Mr. Galloway belongs to the third generation of Galloways who have been in the service of the company. Mr. William Galloway, the oldest, became prominent in a memorable race between the first locomotive built in America and a horse, Mr. Galloway having driven the horse in this historic test of endurance. Later Mr. Galloway became an engineer, which position he held for fifty years. The next in line, Mr. Charles B. Galloway, father of the Federal Manager, was also a locomotive engineer and for many years ran what was known as the "Cannon Ball" express.

Mr. F. H. Clark, formerly general superintendent of motive power of the Baltimore & Ohio, has been appointed general superintendent maintenance of equipment of the Baltimore & Ohio, eastern lines and New York terminals, the Western Maryland, the Cumberland Valley, the Cumberland & Pennsylvania and the Coal & Coke, with office at Baltimore. Mr. Clark is a graduate of the University of Illinois, and entered the railway service as chief draftsman on the Chicago, Burlington & Quincy in 1894, and in 1899 was advanced to mechanical engineer on the same road, and in 1902 to superintendent of motive power, and in 1910 to general superintendent of motive power of the entire Burlington system. In 1911 he was appointed general superintendent of the motive power of the Baltimore & Ohio, which position he held at the time of his appointment, as above noted. At the June meeting of the American Railway Master Mechanics' Association Mr. Clark was elected President. He is also prominently identified with many of the leading railroad clubs and engineering societies.

Making Americans on the Railroad

Mr. Samuel Rea, president, Pennsylvania Railroad System, prepared a statement for the Hon. Franklin K. Lane, Secretary of the Interior. It tells of some of the methods adopted and results achieved in persuading and fitting foreign-born employees of the Pennsylvania railroad to become loyal and useful citizens of the United States. The subject is of particular interest at all times, and more especially at this time, as the United States must, necessarily, rely on people of foreign birth to keep up the labor supply if the further settling and developing the country is to be maintained. It is, therefore, a clear duty to take care of the foreigners who come to America, in order that they may become good citizens, and get an equal opportunity of sharing the benefits of good citizenship.

On the Pennsylvania Lines East of Pittsburgh, at the present time, about 16 per cent. of the total employees are of foreign birth. On the Lines West of that city, operating chiefly in Ohio, Indiana and Illinois, the proportion is somewhat smaller, but it is still quite material. Of the more than 33,000 foreign-born men working on the entire System, about 25,700 are employed east of Pittsburgh, and 7,500 west of that point.

Some years ago, prior to the commencement of the great conflict in which the United States is now one of the leading participants, a canvass was made of the alien employees on all portions of the Pennsylvania System. This investigation showed that Italians greatly predominated in numbers. Today they make up nearly one-third of all employees of foreign birth east of Pittsburgh. It was found, also, that large numbers of the Italians, while they could not properly be termed illiterate, since they could read and write their own language, were nevertheless unable to understand English at all, either in written or spoken form.

With the feeling, for these reasons, that Americanization work was more urgently needed among the Italians on the Pennsylvania Railroad than among the representatives of any other nationality, a correspondence course in Italian-English was inaugurated on the Lines East of Pittsburgh.

This work was placed in direct charge of a native-born Italian, who is also a graduate of Yale, and is an enthusiast on the subject of Americanization. A similar course in Italian-English has also been established, under the charge of a native-born Italian, on the Lines West of Pittsburgh.

After the first few months of the War, as is well known, the labor situation in this country became very acute, and it was necessary for the Pennsylvania Railroad to find and open up new and hitherto untouched sources of labor supply. After careful investigation a considerable number of Mexicans were induced to enter the service. They have been chiefly located along the Main Line between Pittsburgh, Philadelphia and New York. While they have been found efficient and satisfactory workmen on the whole, they, like the Italians, were greatly handicapped by the fact that few could speak any language except their native tongue, which is Spanish.

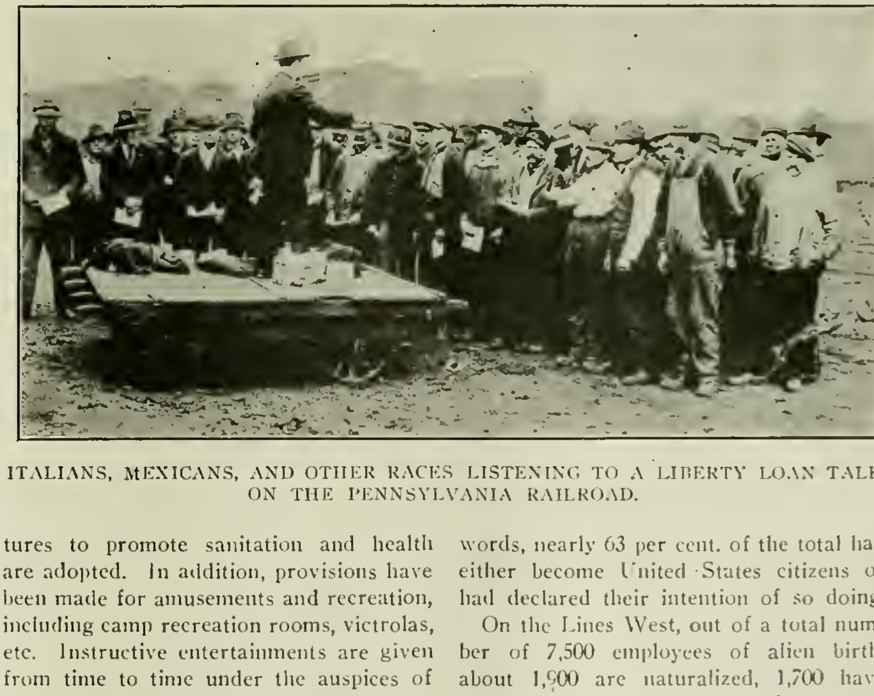
To meet this condition, therefore, a special course in Spanish-English was prepared for the Mexicans, similar to the Italian-English course. On February 28, 1918, there were 451 Spanish-speaking employees learning English in this way.

The Mexican laborers have been chiefly concentrated in camps located at various points along the lines. All modern features to promote sanitation and health are adopted. In addition, provisions have been made for amusements and recreation, including camp recreation rooms, victrolas, etc. Instructive entertainments are given from time to time under the auspices of the Young Men's Christian Association. Wherever possible religious services for the Mexican employees are conducted under the direction of a Catholic church.

In addition to the language courses carried on through the educational organization of the Pennsylvania Railroad, instruction is also provided, by correspondence, in electricity (including elementary mathematics) and in stenography. Altogether, out of approximately 166,000 employees on the Lines East of Pittsburgh, 18,769, or 10.7 per cent. of the total, were on February 28, 1918, enrolled in the educational courses. Supplementing the correspondence courses, numerous safety lectures are conducted solely for the benefit of alien employees.

At the time when the First Liberty Loan was offered to the public, the Pennsylvania Lines East of Pittsburgh and Erie had a total of 25,827 employees who had been born in foreign countries. Of this number, 8,146 employees, or almost 32 per cent. of the total foreign born, purchased Liberty Bonds, and this was within 2 per cent. of the proportion of employees of American birth who subscribed.

To ascertain the proportion of foreign-born employees who had been naturalized, or were in process of becoming citizens, a special analysis was made as of June 30, last. At that time, there were in the service of the Pennsylvania Lines East of Pittsburgh, 25,721 men of alien birth. Of this number it was found that 8,003 had been fully naturalized, 3,069 had taken out their first papers and 5,064 had definitely announced their intention of applying for naturalization. In other words, nearly 63 per cent. of the total had either become United States citizens or had declared their intention of so doing.



ITALIANS, MEXICANS, AND OTHER RACES LISTENING TO A LIBERTY LOAN TALK ON THE PENNSYLVANIA RAILROAD.

On the Lines West, out of a total number of 7,500 employees of alien birth, about 1,900 are naturalized, 1,700 have taken first steps toward naturalization and 1,300 have definitely announced their intention of applying for citizenship.

Our illustration shows a view of a meeting of Italians, Mexicans and men of other races listening to a Liberty Loan talk on the Pennsylvania railroad, and it is gratifying to know that the subscriptions from this source almost equalled the percentage of the American born employees. The purchase of a Liberty Bond by a foreigner is an assurance that a step has been taken toward his Americanization, and the work being done among the foreign employees of the Pennsylvania railroad is worthy of emulation, and no time to begin such work could be better suited than the present.

Commission in the Engineer Reserve Corps.

Applications for examination for a commission in the Engineer Reserve Corps will be received from qualified engineers, the application forms being furnished by the Chief of Engineers, Washington, D. C. The applicants selected by reason of education and experience will be notified when to appear for the professional and physical examination. The commissions embrace the grades of first lieutenant and captain. For the grade of first lieutenant the age is limited between 32 and 36 years; for captain 36 to 42 years. Applicants must be engaged in the active practice of the engineering profession, otherwise no set rules have been established further than that all applicants must be citizens of the United States, and no application will be considered from any one born in a country with which the United States is at war.

Patent Office Examiners.

Examinations for the position of assistant examiner in the Patent Office will be held on August 21 and 22, 1918. Men or women are desired, who have a scientific education, particularly in higher mathematics, chemistry, physics and French or German, and who are not subject to the draft for military service. Engineering or teaching experience in addition to the above is valued. The entrance salary is $1,500. Details of the examination, and places for holding the same, may be had upon application to the Commissioner of Patents, Washington, D. C. Temporary appointments of qualified persons may be made pending their taking the Civil Service examination.

Committee on Standards.

The Committee on Standards are preparing standard dimensions for passenger and baggage cars, and designs for the new cars will be made as speedily as possible. This is the initial movement on the standardizing of all railroad cars throughout the country. Tables are also being prepared in regard to the amount of repairs allowed on cars.

Increase of Wages for Canadian Railway Men.

Announcement has been made that the Canadian war board had decided, after a council with the cabinet, that the Canadian railway employees would receive the same rate of wages as have been awarded to railway employees in the United States. The threatened strike among the railway employees is thereby averted, and the utmost degree of satisfaction is being manifested among the employees at all points in the great railroad system involved in the recent dispute.

Important Change of Address.

The office of the Secretary of the American Railway Master Mechanics' Association has been removed from Room 906, Karpen Building, Chicago, Ill., and is now located in Room 746, Transportation Building, Chicago. All communications should be addressed to the new office.

Sale of Railroad Equipment.

Advices have been received from the Federal authorities that all carriers having railroad equipment for sale are empowered without further authority from their regional directors that no locomotives or cars are to be sold. Rports in regard to such material must be made to the federal managers, who will make such recommendations as they deem necessary.

Traveling Engineers' Association.

The twenty-sixth annual convention of the Traveling Engineers' Association will be held at the Hotel Sherman, Chicago, Ill., commencing on Tuesday, September 10, 1918. The convention of the association has the approval of the federal authorities, and a large attendance is expected.

Willard to Act on Board to Aid Russia.

Mr. Daniel Willard, president of the Baltimore & Ohio, has been selected among others, including a number of American industrial leaders and financiers who are entrusted with preparing a scheme to extend aid to Russia.

Railway Control.

On July 1 the Railroad Administration turned back to private management about 1,700 of the 2,000 so-called short-line roads. Those lines have about 30,000 miles of track, or one seventh of the total railway mileage of the United States.

Railways in Mesopotamia.

At present, engines in Mesopotamia requiring major repairs have to be brought all the way to India and returned after being repaired. The British Government is now making arrangements for the construction of workshops in the former country.

Automobiles.

The seating capacity of the automobiles used in this country is 25,000,000 persons. The seating capacity of the railroad cars is 3,500,000.

We learn little by little; it is only the persevering who ever know much.

Railroad Equipment Notes

The Illinois Central proposes to purchase 7 tank cars of 10,000 gal. capacity.

The Pennsylvania has plans for building a car and repair shop at Cambridge, N. J.

The Union Pacific is inquiring for about 70 tools of miscellaneous description.

The Baltimore & Ohio plans to build additions and install machinery at its shops at Keyser, W. Va.

The Atlantic Coast Line has purchased 80 acres of land at Sanford, Fla., on which to build shops and terminals.

The Chicago, Rock Island & Pacific has ordered two 90-ft. turntables for Burr Oak, Ill., and Bureau, 114 tons, American Bridge Company make.

The American Locomotive Company plans to build an addition to its boiler-shop at Schenectady, N. Y. The new portion is to be 120 by 175 feet.

The New York, New Haven & Hartford has placed an order with the Brown Hoisting Machinery Company, of Cleveland, Ohio, for 10 locomotive cranes.

The Railroad Administration has approved an appropriation of $500,000 for the construction of locomotive shops at Tipton, Ind., for the Lake Erie & Western.

Orders for headlight cases for the United States standard locomotives have been placed as follows: 765 Shroeder Headlight & Generator Company, 500 Handlon & Buch, 500 Adams & Westlake.

Water gauge cocks for the 1,025 United States standard locomotives have been ordered from the Nathan Manufacturing Company. Superheaters for the locomotives will be built by the locomotive builders on a royalty basis.

The Union Pacific has awarded contracts to the Zeigler & Dalton Construction Company, Junction City, Kan., for improvements to be built at Junction City, including a new roundhouse, powerhouse and other buildings, to cost about $300,000.

Bids are being received by the American Locomotive Company on the erection of a one-story, 120 by 125-ft. addition, to its boiler shop at Schenectady, N. Y. The company also is receiving bids on a one-story, 80 by 125-ft. addition to its plant at Dunkirk, N. Y.

Contracts have been let by the Missouri, Kansas & Texas for new terminal buildings at Appleton City, Mo., including a roundhouse, 37 by 188 ft.; storeroom and oil house, 30 by 72 ft.; boiler and pumphouse, 31 by 63 ft., also office buildings, lodging house, etc.

The allotment of orders for the journal boxes for the government standard freight cars are as follows: Journal boxes for 4,000 cars have been ordered from McCord & Company, and the order from the Haskell & Barker Car Company has been reduced from 8,000 to 6,000.

It is understood that the U. S. Railroad Administration will soon place orders for 390 locomotives in addition to the 1,025 ordered several weeks ago. The new orders are to include 100 switching engines, 175 light Mikados, 57 heavy Mikados, 15 heavy Santa Fe type, 13 light Pacifics and 30 Consolidation engines.

The Cleveland, Cincinnati, Chicago & St. Louis has ordered from the Federal Signal Company an electric interlocking plant to be put in by the builders at Bellefontaine, Ohio. The machine will have 68 working levers and there will be detector circuits and sectional route locking throughout. The machine will be type 4, direct current, with alternating current indication.

The Chicago, Burlington & Quincy is inquiring for an 18-in. by 7-ft. 6 in. engine lathe; 14-in. by 4-ft. 6-in. lathe; 30-in. radial drill, double-end punch and shear with a 20-in. throat to punch 1-in. hole; 20-in. heavy-duty shaping machine, 1½-in. single-head bolt cutter, draw cut high-speed power saw, 50-lb. power hammer and a combination rip and cross-cut saw with boring attachment.

The Pennsylvania Railroad has ordered an electro-mechanical interlocking plant for Birmingham, N. J. The machine will consist of a 4-lever mechanical frame, with 7 electric units. It will be provided with electric detector locks on all switch levers and electric indication locks and electric light indicators on all working levers. The Union Switch & Signal Company will furnish this machine.

The Chicago, Milwaukee & St. Paul has plans for extensive terminal improvements at Ottumwa Junction, Ia., which include an eighteen-stall roundhouse, an eighty-five foot terminal building, a water softening plant, a power house, water tanks and other structures. The necessary track work will be done by the St. Paul's own force. The contracts for the buildings have been let to two Chicago firms and the estimated cost is $500,000.

Books, Bulletins, Catalogues, Etc.

Railroad Men's Mountain Home

The board of directors of the Railroad Men's Mountain Home Association has issued a report setting forth the progress that is being made in establishing a home for railroad men. The association already owns 160 acres, located near Denver, Col., and in an ideal location about 2,000 feet above the level of the city. Accommodation for 50 inmates in the cottages and other buildings is already complete, and the earnestness with which the work is being taken in support of the good cause is particularly gratifying. While the full development of the scheme may take some time, it may be briefly stated that at present it takes the form of what may be called a recuperative camp, and is not intended for hospital work or surgical cases, but a home where convalescent railroad men will receive the full advantage of Colorado's sunshine and pure mountain air, and may regain health and strength under ideal conditions. Contributions to the worthy cause may be sent to L. P. French, Acting Secretary, Union Depot, Denver, Col.

An Investigation of Twist Drills.

Bulletin 103 issued by the Engineering Experiment Station of the University of Illinois records a series of interesting experiments disclosing certain facts regarding the performance of metal drills. One-inch drills of many well known standard makes and special cast-iron blocks made in the shop laboratories were used. The power required at the drill point for various speeds and rates of feed was noted in all tests, the thrust and torque of the drill were recorded by special dynamometers, and the endurance of drills of different designs was studied. The economical helix angle, point angle, clearance angle, speed and feed were determined, and the effect of pilot holes and rounded corners were shown. The tests were conducted by B. W. Benedict, Director of the Shop Laboratories, and W. P. Lukens, Research Fellow in the Engineering Experiment Station. Copies may be had gratis on application to C. R. Richards, Director, University of Illinois, Urbana, Ill.

Electrification of Railroads.

The Westinghouse Electric & Manufacturing Company has issued a special publication No. 1588, pointing out the fact that during the last ten years railroad expansion has not kept pace with industrial growth. Rate ruling and unwise legislation deprived them of the surplus necessary for expansion, leaving them only the bare necessities for a precarious existence, and we are now demanding, in order to relieve congestion and increase efficiency, that they do the very things we only a short time back passed laws to prevent. It is certain in the near future that there will be much activity along the lines of electrification. Two excellent essays, one by F. E. Wynne, and the other by Q. W. Hershey, point out very clearly that electrical installation is being called upon to supply the method of meeting the requirements of intensified operation. The effect of mountains is virtually eliminated. It is claimed that where under steam operation, thirty or forty per cent. only of the total hours have been spent on the road, now ninety per cent. of each twenty-four hours may be given to service on the road by the use of electric engines. Many other advantages are pointed out, and a fuller electrification of railroads is urged as a war measure. The bulletin is finely illustrated.

Locomotive Fuel Economy.

This is one of the series of popular handbooks published by the Federal Railway Institute for self-instruction, and contains twenty lessons in locomotive fuel economy in the question and answer form, and covers the three examinations as required by some of the railroads. As is well known, locomotive firemen must have technical instruction combined with practical experience, and must pass graded examinations before qualifying as locomotive engineers. In the work before us a sincere effort has been made to invest the subject with an interest that engages the attention of the earnest student, and as fuel economy is a question of surpassing interest at the present time, the book cannot fail to meet with popular approval. The numerous illustrations are easily understood, and the book is handy in form and bound in flexible leather. Copies may be had from the author, Frederick J. Pryor, 204 Grand avenue, Milwaukee, Wis. Price $1.50, postpaid.

Staybolts.

The current issue of the organ of the Flannery Bolt Company, Pittsburgh, Pa., reminds its readers that the minimum carload shipments have precedence over less than carload lots, so that in estimating the required stock it would be well to consider the tonnage that will move the quickest in the makeup of supply orders. The railroads are accomplishing a mighty task, and it is interesting to know that repairs on locomotives for the Government controlled railroads are now passing through shops at the rate of 4,800 engines weekly, or 700 more than a year ago.

Weights of Various Coals.

The Government Printing Office has issued a technical paper by S. B. Flagg on "The Weights of Various Coals," from which it appears that the heavier weights of coals may be expected among those of high fixed carbon content than from those of low. Increased ash content seems to lower the unit weight. It also appears that the coals high in moisture are lighter than those low in moisture and the younger coals are lighter than the older coals. It is difficult to determine from the data available anything more than a general trend. The weights run from 41 lbs. per cubic foot, reported from Raleigh County, West Virginia, to 58 lbs. per cubic foot, from Schuylkill County, Pa.

The Petroleum Industry.

The National Petroleum War Service Committee has issued a circular relating to a proposed Government control of the petroleum industry, where it is stated that it may be entirely possible that we are in the future going to undertake some exceedingly drastic measures. Certainly we shall if this war lasts long enough. National necessity knows no individual. If necessary, the petroleum industry will be unified to an extent not now dreamed of; but no matter what that unification may be, how complete it may be, even to the point of handling it as absolutely one unit, there is no reason why on the whole the members of that industry should be seriously injured because of the tightening of Government control.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

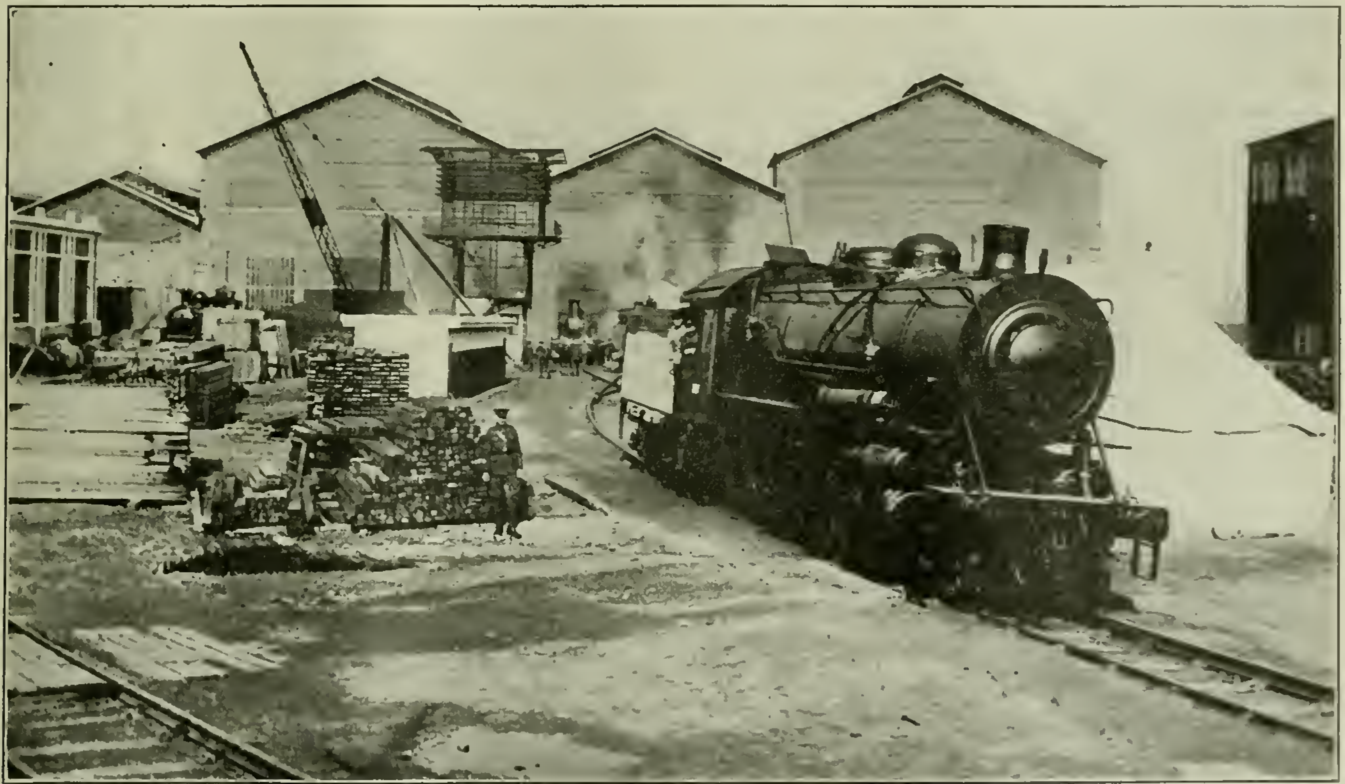
Vol. XXXI 114 Liberty Street, New York, September, 1918 No. 9

The Railway Army Corps—First in War and First in Peace

The half-tone illustration, which we show this month, gives a representation of a finished American giant locomotive, turned out of a British railway shop "somewhere in France," and it may serve as an introduction to a few words about one part of the vast war machine whose magnitude is not fully appreciated by the average layman. The American engine at the British base railway shop brings home very closely the fact that there is a clear and unified understanding between the two nations, and a hearty co-operation between these powers that emphasizes the happy goodwill between the two which now constantly prevails.

It was Napoleon's famous dictum that an army marches on its stomach, an expressive way of saying that an army can fight and move forward only as long as it regularly receives all the necessities for its daily existence. In probably no other war have communications played such an important part, since they have practically dictated the strategic conceptions of the higher commands on both sides. The vast numbers of men that make up the armies of today necessitate the handling and the transportation of hitherto unheard of quantities of supplies, while modern methods of fighting use up ammunition in quantities never before imagined.

It is not too much to say that whatever successes the Germans have won in their campaigns on land have been mainly due to the network of strategic railways that they had built up within their own borders in the years preceding the war and to the additional fact that during their rapid advance into Belgium and France they seized and converted to their own use the finest and most vital of the French railway systems. By the skillful use of their railways, and those they stole,



AMERICAN WAR LOCOMOTIVE ASSEMBLED AT BRITISH BASE IN FRANCE.

British Official Picture, London, England. Press Illustration Service, Inc., New York.

they have been able all during the war to shift troops rapidly from the eastern front to the western front, or vice versa, and so concentrate an overwhelming number of men at any selected point of attack which they chose, and at the same time retaining the ability to break off, if danger threatened elsewhere, and rush their reserves to whatever part of the line they believed to need them most.

After the first rush to Paris had been checked at the Marne, and the French and British had thrown the Germans back to their prepared positions on the Aisne, the long period of trench warfare set in, and the Allies devoted their utmost energies to improving their communications. Whole stretches of railway line in England were torn up and shipped to France, so also Canada did the same; they were relaid in France and by the end of 1917 a total of over 2,000 miles of track had been so dealt with. The British railways were stripped of every piece of rolling stock that could possibly be spared, and their skilled employees were formed into special railway battalions, which were sent to France for the building and maintenance of the lines in the British Army zone. In addition, many battalions of skilled railwaymen were recruited in Canada and hurried across the seas. These men, most of whom had been engaged in construction work upon the huge Canadian Trans-Continental railway systems, enlisted by whole gangs at a time, their own foremen being appointed as officers, so that in the transformation from civilian into military life they lost none of the advantages of the system under which they had previously been working. The speed with which they followed with their rails the victorious advance of the British Armies in 1916 and 1917 was one of the real surprises of this most surprising war. Vimy Ridge had not been in possession of the Canadians for more than four days before a line of steel rails had been pushed far into the heart of what had been but ninety-six hours earlier the German artillery positions. At the taking of Messines Ridge a month or so later, the railway troops had completed their first line and run a train into the village of Messines just two days after the titanic combat had started, and before the opposing forces had had time to stabilize themselves after the British lurch forward.

In addition to the construction battalions, special companies of operators consisting of conductors, enginemen, firemen, train despatchers, etc., were formed, and day and night these men are operating the intricate thread of railways that reach from the British bases on the English Channel to within a few miles of the front line trenches. Often their trains are the targets for the German long-range guns and much more often are they the recipients of attention from Hun aeroplanes which flew over the lines at night, laden with their death-dealing missiles and follow for many miles the railway lines looking for the glare from a firebox that will betray the presence of a train laden with precious food or ammunition, or yet more precious lives. At other times, baby killing is more their idea of war, which has always disregarded the laws of God and man. But a stretch of track is no sooner damaged than a work gang is put on the job, heedless of the danger overhead, or near them, the men are intent only on keeping the line open and running, so that their comrades in the trenches shall want for none of the things that a soldier needs, those vital necessities of war, of food, clothing, and ammunition, the want of which means the difference between life and death to "our boys" Over There.

Whenever one speaks of the railway men in this war, one cannot forget the brave fellows from America. These men had hardly got over there and started work when General Byng's army moved forward in victorious fight. The American Engineer Corps were caught in one of the eddies of the great battle, but how heroically and how eagerly they let go the trackjack, the shovel and the lining bar and seized rifle and bayonet, and wrote their name large on the ranks of the agressive foe in the fields of down-trodden, but enduring France, is now a matter of glorious history and a matter of pride in the future.

Economy in the Use of Water

The municipal authorities of New York are said to be giving serious attention to the question of economy in the use of water. That the waste is very great is well known, but whether a special commission would subtract from or add to the expense is doubtful. Commissions are always costly, and water is cheap. This leads us to observe that the subject of the economy in the use of water on railroad operations is one that has received very considerable attention and might receive more. Quite recently Mr. C. R. Knowles, superintendent water service Illinois Central Railroad, contributed an able paper on the subject, wherein he presented some startling, figures, claiming that the estimated annual consumption of water by locomotives alone on the railroad of the United States amounted to 450,000,000,000 of gallons. The cost of furnishing this water, not including maintenance, interest and depreciation of water stations was said to exceed $16,000,000 per year. Water for other than locomotives' supply is not included in the above figures. The total consumption for all purposes is an excess of 625,000,000,000 of gallons per year, with a total expense for all water, including maintenance, interest and depreciation on plants, of over $30,000,000 per year.

Nearly 13,000 water stations are maintained to supply the water required by 60,000 locomotives. As is well known, the development of transportation by rail has made it necessary to provide improved facilities in every branch of railway operation. While water supply is among the most important of these requirements, it has perhaps received less consideration than almost any other department, many railroads being apparently indifferent to the necessity for more economical and serviceable installations. While many of the water stations constructed 20 years or more ago are still in use, the expense for maintenance and operation is often excessive and an adequate supply uncertain. With freight trains on important trunk lines of low gradients loaded with 2,000 to 5,000 tons and engine tender storage of 9,000 and 10,000 gals., the development of a water supply may certainly be classed among the most important features of modern railway operation. Not alone is the demand for an increased supply, but the higher pressure carried and the importance of maintaining fast passenger and freight schedules, together with the loss of time through keeping locomotives out of service for washing and repairs on account of bad water, has created a demand for water of a better quality than that of former years.

In the selection of a railway water supply, two important features are to be considered: first, the water must be satisfactory as to quality, and second, it must be available in sufficient quantity. To secure an ample supply of satisfactory water, it is often necessary to pipe it from a distance. If water from surface supplies is not available within a reasonable distance, consideration should be given to water from ground sources, or from impounding reservoirs, if a suitable location may be found.

Impounding reservoirs are frequently found necessary for storage of water when a suitable supply is not available from other sources. The most economical and satisfactory method of constructing an impounding reservoir is by damming up a valley, if one may be found suitable for the purpose.

The general tendency of railroads has

been to attempt to standardize the pumping equipment along with other common standards, it being assumed in many instances that if certain equipment gave good results under certain conditions, that it should be adopted as standard and used in all cases, regardless of local conditions. While it is desirable to adopt certain standards as applying to water supply, such as tanks, pump houses, etc., it is a mistake to include the pumping equipment in such standardization, except where such equipment will not be materially affected by varying conditions so often found in establishing a pumping station.

Steam is most commonly used in pumping water and is economical or otherwise, according to the installation and location with regard to fuel supply. In localities where coal is plentiful and a low grade, such as raw screenings, may be secured without a long haul (aside from the question of attendance) water may be pumped by steam almost as economically as by any other power and generally with a great deal more reliability and lower cost of upkeep. This is especially true where a large quantity of water is pumped.

Gasoline engines, while never the most economical pumping units, are less so with the increased cost of gasoline and the expense of operating these engines, except on a lower priced fuel than gasoline, is almost prohibitive. Gasoline engines now in service may be converted into oil burning engines by the use of attachments for vaporizing the heavier oils before they enter the cylinder. While these engines are not as economical in the use of oil as the Semi-Diesel engine, the cost of operation is much less than with the use of gasoline.

Oil engines are not as flexible as steam pumps and their use is necessarily limited to a certain extent, particularly where there is a wide range of duty, as they will not operate successfully under an overload and providing excess power cuts down the efficiency, as the maximum efficiency is obtained where the engine is operating under full load. They are coming into greater favor, as the centrifugal pump is being developed, as an oil engine and centrifugal pump makes an ideal installation under favorable conditions.

Up to within the past few years, standard tanks rarely exceeded a capacity of 50,000 to 60,000 gals., while the tanks on many lines today include tanks holding 100,000 to 150,000 gals., and even 200,000 gals. While the tendency toward larger tanks has been marked, the development along this line has been all too slow and the efficiency of the water service impaired to a great extent by limited storage. Particularly is this true at terminals where a large number of engines take water in a limited time, and at road side stations, where the capacity will not carry over without the employment of night pumpers, thus materially increasing the cost of water. It is not economy to erect a tank good for a life of thirty or forty years and then find within a few years that it is too small to supply the demand without continuous pumping.

The construction of large tanks has been retarded to some extent due to the question of a permanent location, on account of the possibility of track changes and other construction features. By installing penstocks, it is possible to select a permanent location for a tank, remote from the track and out of the way of future construction. In addition to permitting of a more satisfactory location of the tank, a penstock offers many other advantages, as it does not obstruct the view of signals, etc.; offers better drainage and gives less trouble from soft track and ice in winter, is less liable to strike trainmen and cars than a spout suspended over track, and may be more readily protected from freezing than the gooseneck and valves of tank.

In regard to the treatment commonly in use to reduce impurities in water, there are two methods to be followed in the treatment of boiler water. It may either be purified by treating plants before it enters the boiler, or it may be treated inside the boiler by the use of compounds. Concerning interior treatment, while in the case of stationary boilers conditions are favorable for the use of compounds, the interior of a locomotive boiler is so small in proportion to the steaming capacity that there is a definite limit to the permissable viscosity of the water. Time for reaction is a factor also and as a general proposition interior treatment would appear inadvisable. The proper treatment of locomotive boiler water is by means of a purifying or softening plant before it enters the boiler, although it is decidedly better to use some sort of compound with bad water than to eliminate the treatment altogether.

This lack of co-operation, due to ignorance of the value of water, sometimes aided and abetted by departmental lines and jealousies, causes thousands of dollars' needless expense. American railroads consume daily approximately 1,750,000,000 gals. of water, at a daily expense of about one hundred thousand dollars. These figures should be enough to convince almost any one that water is not free, and that a saving in water is quite as important as a saving in coal, oil or other supplies. It is safe to say that 15 per cent of all the water used by railroads is waste. By waste is meant that quantity of water drawn in excess of the amount actually required.

Large quantities of water may be wasted in taking water at tanks and penstocks. Not only does this cause a waste of water, but it causes an additional expense for removing ice from track in winter months and repairs to soft tracks during the summer. A conservative estimate of the total cost of this waste per annum is $60 per tank, or 5 per cent on $1,200, and will pay the interest and depreciation on the cost of construction of a new 100,000-gallon tank at each station in five years.

With the exception of a few of the larger railroad systems, no distinct water departments are maintained. On the majority of roads the development of water supply and design and construction of water stations is handled by some one in the engineering department in connection with other duties, while the maintenance and operation comes under the supervisor or foreman of bridges and buildings, whose principal duties are along other lines. In fact, providing water for locomotives and other railway purposes is a feature of railway operation that varies more widely than any other department on the railroad, and at the same time its importance, in view of the need of economy in every department, cannot be overestimated.

The many different methods of handling water supply on railroads may be accounted for in the fact that within comparatively a few years ago this department of the railroad was not considered of any great importance, as the quantity of water required was not great, the reconstruction of the existing organization, placing the forces used in water service on a definite basis, with a supervising head directing the energies of the department in the proper channel. In fact, reorganizing the water service forces as a distinct unit would, on many roads, effect an actual reduction of force.

A water department organization does not always mean that the division or local forces are materially changed where water service men are locally employed, and the nucleus of an organization exists, but rather that the local officers and engineering department are relieved of the duties incidental to the design and development of water facilities and the work placed in the hands of those trained along this particular line. That there is an urgent necessity for such an organization has been proven by the results obtained by the roads who have established a department to handle this very important feature of railroad operation.

The water question in the future will undoubtedly become more perplexing than it has ever been before. With the rapid advance that the chemical industry has made in the United States, it can be readily foreseen that the time is near when the waste from these industries will affect the water supplies and create a serious problem, but in this, as in all other questions of growing importance, doubtless the difficulty will be overcome.

The History of Locomotive Feed Water Heaters

By J. SNOWDEN BELL, NEW YORK

Two years ago the American Railway Master Mechanics' Association appointed Mr. J. S. Bell as a committee of one to prepare a report on Feed Water Heaters. Mr. Bell's article is encyclopædic and practically puts all that is now known of the art on record. We are only able to print the salient features of this admirable and exhaustive paper.

The economic value of an appliance by which any substantial portion of the heat units contained in the waste gases of combustion and the exhaust steam of a locomotive can be made available in heating boiler feed-water, is too obvious a proposition to require discussion, and it was recognized by engineers at a very early day. While numerous appliances of this character have from time to time been experimented with, and have ordinarily failed to prove sufficiently satisfactory in practice to cause them to be continued in regular service, the undeniable correctness of the general principle upon which they are based warrants, if not positively demands, its renewed consideration, particularly in view of the rigid economies in every department which present conditions have rendered indispensable. Mr. A. L. Holley wrote fifty-six years ago:

"It is impossible to state the exact economical results of feed-heating—either the saving of fuel or the cost of repairs; because no experiments which fairly estimate all the conditions have been made. It is quite sufficient, for present purposes, however, to know that there is a saving worth making." The position of Mr. Holley, above stated, was, forty years later, endorsed by Mr. M. N. Forney, whose universally recognized ability and practical experience in American locomotive work render his opinions on that subject reliable and of value.

Feed-water heaters are of two different types, which may be termed, respectively, "surface" heaters, being those in which the heating medium, either gases or steam, is applied to the surfaces of channels or passages (usually tubular) through which the feed-water traverses on its way to the boiler, and "injection" heaters, in which steam is discharged directly into the feed water. The former type, in which the transfer of heat from gases or steam to the feed-water is effected through walls of comparatively thin metal, is that which has been the more frequently experimented with, and, for several reasons, would seem to be the more practical and desirable of the two types. Subordinate to the division into the two types last mentioned, a classification of feed-water heaters might be made with reference to their location on or in a locomotive boiler, the earliest proposed and most extensive division of which includes those which are enclosed in a casing supported on the side or top of the boiler. The next design that was developed placed the heater in the stack, which position could be adopted with the low boilers of small diameter which were in service when it was presented, but which is manifestly inapplicable in present practice. Succeeding this, the heater was located in the smokebox, or around it, and later in the forward portion of the waist of the boiler, as revived in Mallet locomotives of comparatively recent construction. Other locations were proposed by different designers, among which may be mentioned the tender tank, the locomotive ash pan, the fire-box door deflector, the grate bars, the exhaust pipe, the cylinder saddles and the boiler tubes.

The earliest record of a feed-water heater design is thought to be that which is presented in a British Patent of 1802, granted to Trevithick & Vivian, for "Steam Engines for Propelling Carriages, etc.," and the appliance, which is rather crudely represented in the drawings of the patent, is shown in Fig. 1. It is very briefly described in the specification, the only matter referring to it being the following: "The steam may escape into the outer air, or be directed and applied to heating fluids or other uses." In another view is represented a method of heating the water for feeding the boiler, by the admission of steam after its escape into the cistern. The steam passes under a false bottom, perforated with small holes, and heats the water therein, a portion of which water is driven at every revolution of the fly by the small pump through into the boiler.

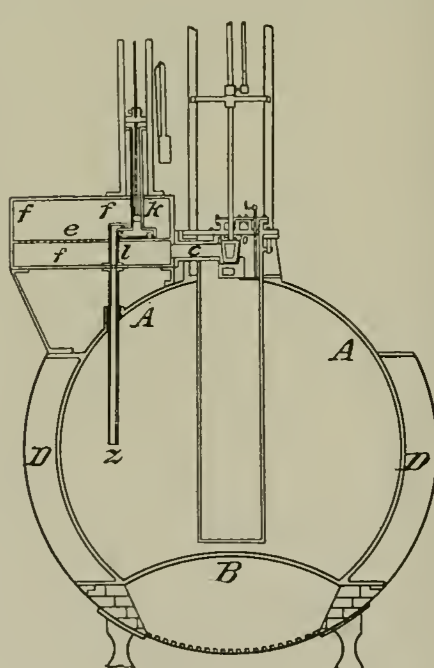


FIG. 1.—TREVITHICK & VIVIAN, 1802.

Among his references to the work that had been done in this line by Goldsworthy Gurney, the author makes the following statement: "Mr. Goldsworthy Gurney, in 1825, produced a steam carriage; and his improvements upon it led to the successful introduction, by Lieut.-Col. Sir Charles Dance, of steam carriages on turnpike roads, as an established and regular conveyance for the public betwixt Gloucester and Cheltenham in February, 1831."

The locomotive "Royal George" was put in service on the Stockton & Darlington Ry., in England, in October, 1827. This engine is stated to have been fitted with a feed-water heater, and its application is believed by the writer to be the first that was made to a locomotive. The feed-water heater is not shown in the illustration which goes with Mr. Bell's report.

The single pipe "surface" feed-water heater of Gough was improved and brought to the multitubular condition in which it was applied in the then most recent designs by Ross Winans, the celebrated locomotive builder of Baltimore, who applied it in the "grasshopper" and "crab" engines of the B. & O. in 1836 and thereafter, in connection with a fan wheel, which was driven by the exhaust steam. The Winans heater consisted of a cylinder, which may be 24 ins. long and 15 ins. in diameter, for an ordinary locomotive engine, the cylinder having inner and outer heads at each end. Tubes, of say ⅜ in. diameter, extend from one inner head to the other, and the steam passes into one end of the cylinder, through the tubes and out at the opposite end: The feed-water passes around the tubes.

The U. S. Patent of Z. H. Mann and L. B. Thyng, of Lowell, Mass., 1838, for "Mode of Constructing Locomotive Engines," is the earliest design which has been found in which it is proposed to locate a feed-water heater in the stack. The boiler has a return flue, which may be 8 ins. in height and 12 ins. in breadth, and what is termed "a cylindrical space or tube for water" is placed in the stack, the feed-water being supplied to it, at the bottom, from the pumps.

The Mann & Thyng patent is also thought to be the earliest record of a proposal to heat feed-water by passing a portion of the exhaust steam into the tender. The specification describes what the patentees term their "simple apparatus," which consists of a valve box to

receive the exhaust steam, about 4½ ins. wide and 6 ins. long, in which are placed two pipes, one leading to the exhaust pipe and the other carrying exhaust steam to the tender, the proportion delivered to the tender being controlled by a valve in the valve box. The principle of heating water in the tender tank by exhaust steam, which was hardly more than outlined by Mann & Thyng, was thought to be a good one by many subsequent designers.

Zerah Colburn, in his small treatise, The Locomotive Engine, Philadelphia, 1851, wrote as follows:

"We will add a few particulars of an engine for burning bituminous coal, which was constructed for the B. & O. R. R. by Thatcher Perkins, master of machinery on that road. Attached to the boiler of this engine was the patent apparatus for heating the feed water by the surplus exhaust steam of the engine, which was invented by Mr. Perkins. The exhaust steam from both cylinders enters a square box in the center of the smoke box. In this box is a movable valve by which the steam can be discharged through the ordinary blast pipes or turned into a pipe leading to a steam casing surrounding the smoke box. This pipe also continues along beneath the boiler, and is united to a steam belt surrounding the same at the fire-box end, and from which the steam finally escapes through a pipe for that purpose. The feed water can be admitted directly to the boiler, near the fire-box end of this pipe, or which is intended in running, it can be pumped into a casing surrounding this pipe, from whence it passes into a water casing surrounding the smoke box and within the steam casing already mentioned.

Smith & Perkins built, between 1852 and 1854, fifteen locomotives for the Pennsylvania R. R., all of which were of the type with six 44-ins. driving wheels. and a pair of forward bearing wheels in rigid pedestals.

J. E. McConnell, a prominent English motive power officer, made a number of improvements in locomotive design, among which was a feed-water heater in which it was proposed to utilize the heat of the gases passing through the smoke box, and the steam passing through the high exhaust pipes, which were standard in English locomotives of his time. This appliance is shown in his British Patent, 1851, and will be understood by reference to Fig. 2, which is reproduced from this patent.

A French patent, dated in 1851, was granted to Herr Kirchweger, of Hanover, for an apparatus stated to be for allowing the steam of locomotives, after it has done its work, to escape, at the will of the operator, either from the exhaust pipe or into the tender, for the purpose of economizing water and fuel, whereby variation of the exhaust nozzle will be superfluous. Le Genie Civil, 1912, p. 308, in an article on locomotive feed-water heaters, refers to the Kirchweger system as one that has had the most success, and states that it was tried on a locomotive of the Paris, Lyons & Mediterranean Ry. in 1854. The conclusion of the last trial was that the apparatus effected an economy of from 10 to 12 per cent.

M. W. Baldwin, of Philadelphia, and David Clark, Master Mechanic of the Mine Hill Railroad, Schuylkill Haven, Pa., were granted U. S. Patents in 1854 for a feed-water heater which, as described in the Illustrated Catalogue, Baldwin Locomotive Works, 1874, was placed at the base of a locomotive chimney, and consisted of one large vertical flue surrounded by a number of smaller ones. The exhaust steam was discharged from the nozzles through the large central flue, creating a draft of the products of combustion through the smaller surrounding flues. The pumps forced the feed-water into the chamber around these flues, whence it passed to the boiler by a pipe from the back of the stack. Another form of feed-water heater located at the base of the stack was patented by R. A. Wilder, also of the Mine Hill R. R. (U. S. Patent granted in 1854).

James Milholland, who was at the time in charge of the Motive Power Department of the Philadelphia & Reading R. R., fitted a feed-water heater on the engine

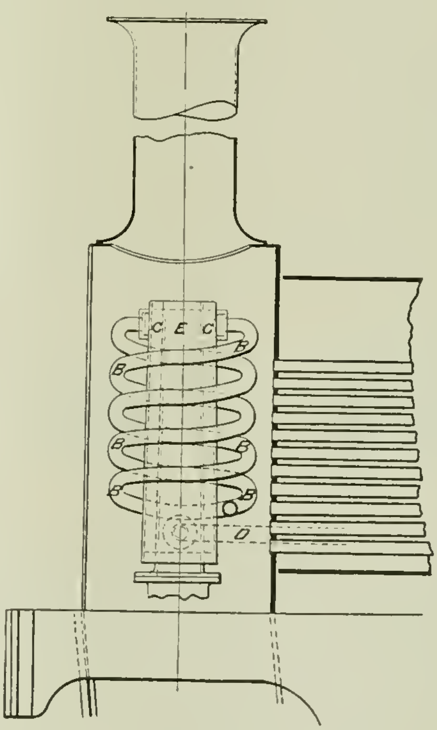


FIG. 2.—J. E. McCONNELL, 1851.

"Juniatta," which was built at the Reading shops of that road in 1855, and was of the same type as the Smith & Perkins engine. Mr. I. A. Seiders, Supt., M. P. & R. E., Philadelphia & Reading Ry., reports as to this heater as follows: "We have no records or prints of this device, except an original picture of this engine, which shows the feed-water heater to be of the drum type, suspended under the right-hand running board. Exhaust steam was piped to the front end of heater from main exhaust and left the rear end of heater, being piped to ash pan. The feed water enters the rear end of the heater drum from feed pump and leaves the front end, being piped to boiler check on front course of boiler. Two heaters of this type were still in use about 1881, one being applied to a Consolidation type and the other to an American type locomotive."

The drum of the heater was tubular, the steam passing through the tubes and the water around them. The general principle and essential features of the Milholland heater form the basis of many appliances of the same type, which, under various modifications of detail, have been, from time to time, subsequently produced and put in practice. The "Juniatta," which is reproduced from the drawing referred to by Mr. Seiders, and shows the feed-water heater quite plainly, although on a small scale. The construction of the Milholland feed-water heater was substantially similar to that which illustrates a feed-water heater applied by W. S. Hudson, of the Rogers Locomotive & Machine Works, in 1859, shown in Fig 3.

D. K. Clark, the well-known English engineer and author, designed a feed-water heater which is the subject of his British Patent of 1859. This heater, which was of the "injection" type, is illustrated in Holley's book before referred to, and will be readily understood by the following description of it:

"The most simple and compact heater that has appeared, and, obviously, the most effective, for its cost and dimensions, is that by D. K. Clark. The principle is similar to that of the steam jet for coal-burning—the forcible and immediate inter-mixture of currents or jets of water and steam brought into direct contact and traveling together. One or more jets of steam are discharged freely and directly through a pipe or other passage, or chamber of suitable form, into which also the water to be heated is delivered, and through which it is passed in conjunction with the steam. In this confined passage the steam, in virtue of its initial velocity, forcibly impinges upon, disperses and mixes with the water, and is quickly condensed, and the water is raised in temperature by the heat of the condensed steam. The jets of steam should be so adjusted as by suction to draw and conduct the water into and through the heating chamber, after the manner of the blast pipe."

William Stroudley, Locomotive Superintendent of the London, Brighton & South Coast Ry., England, equipped a number of locomotives with a feed-water heater, in which a portion of the exhaust

steam was discharged into the tank, as in the Mann & Thyng, Ayres, and Kirchweger systems before noted. An 0-6-0 type locomotive of the L. B. & S. C. Ry. is described thus: "In addition to the blast orifice, which is large, namely, 4½ inches, there is a 4-inch pipe from the exhaust passage in cylinders to the surface of the water in the tender. A stop valve is provided in the blast pipe, worked from the footplate, as also another in the 4-inch heating pipe, the object being to shut nearly all the blast off the fire when shunting at stations, so as to avoid waste of steam at the safety valves and to heat up the water in the tender. By this means the feed water is generally heated to boiling point, and to still further avoid waste, a steam donkey pump is provided on the footplate, this pump being large enough to supply the boiler should the other pumps fail."

The Chemin de Fer du Nord applied at one time a feed-water heater. I put water into the boiler at a temperature near the boiling point, and the same road also tested the Korting reheating injector. This latter appliance comprehended two

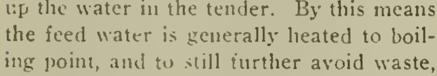


FIG. 3.—W. S. HUDSON, 1859.

distinct apparatuses: the injector, properly so-called, which fed warm water, and the reheater, which increased its temperature before its entrance into the boiler. The injector proper was really formed of two superposed injectors, the water discharged from the first one being forced into the boiler by the second. The reheater is a casing filled with small tubes, through which the feed-water from the second injector passes, the exhaust steam circulating around the tubes.

Geo. S. Strong, who will be remembered as the designer of the Strong valve gear and locomotive boiler, which were experimented with on the Lehigh Valley R. R., and others, commencing about 1880, was granted four U. S. Patents for feed-water heaters. Each of these designs proposed to heat feed-water by passing it through a casing, around a set of tubes in which exhaust steam traversed upwardly and downwardly in inner and outer tubes of the Field type, and thereafter to pass it through a filter before being delivered to the boiler. In the two latter patents, live steam heating coils of pipe were added.

A feed-water heater placed in the smoke box, but of different form from any of that type that preceded it, is shown in the U. S. Patents of W. H. Rushforth. The heater in each case being located immediately in front of the smoke box tube sheet, in the manner of the present standard deflecting plate and being, in the first patent, a rectangular "water drum," and in the two latter ones a "coil" of straight horizontal pipes connected by return bends. This was in 1885-8. The Union Pacific R. R. show the Rushforth heater as applied on a number of locomotives of that road. The feed-water is delivered from the pumps or injectors to the coil through nozzles at the sides, and after passing through the coil in which it is heated, enters the boiler through a connection at the top of the coil.

J. H. McConnell, then Superintendent of Motive Power of the Union Pacific R. R., in a committee report on Bulging of Fire-box Sheets, submitted at the 1895 Convention of the Association, gave an extremely favorable account of the performance of the Rushforth heater on that road, from which the following excerpt is made: "The most successful method of taking care of our boilers in bad water districts has been by the application of the Rushforth Feed Water Heater. Have now about fifty of these in successful operation. Results have been very satisfactory. On the seventh district of the Wyoming Division, where the water is largely soda, it has been our practice, and an absolute necessity, to wash the boilers out after making a trip of 137 miles. This practice has been in operation for the past twenty-five years, and until the heaters were applied to the engines. Since the application of the heaters the engines run over that district thirty days without washing the boilers." — (*Proceedings*, 1895, p. 80.)

McConnell also says that he has been enabled to open the nozzle ¼ inch; that the engine steamed freer and carried water well on the hills; and that, with the heaters, the engines carry 3 inches of solid water in the glass, shut off.

An exhause steam feed-water heating appliance, known as the Davies & Metcalfe locomotive exhaust injector and grease separator, was tested on the Pennsylvania R. R. in the fall of 1899, and was also applied on two locomotives of the Chemin de Fer de l'Ouest France, in 1900.

The mechanical ability of the late M. N. Forney; the analytical mental processes with which he exercised it; and the conservatism which characterized his judgment as to undeveloped, or partially developed theories, involving possible lack of merit from a practical standpoint, are all familiar to those who intimately knew him, including many present members of the Association. His expressions on the subject of heating feed water, so clearly indicate an intelligent and favorable view of the subject that it could reasonably be hoped that he had developed a feed-water heater in which theoretical economy would not be overbalanced by structural and maintenance expense. The feed-water heaters of the Forney patents are both of the smoke-box type, that of No. 632,708 being enclosed in a casing surrounding a smoke box which it extended considerably beyond the cylinder saddles, and that of No. 688,402 being in and below an extension of over 100 per cent of the length of the smoke box. In the first mentioned patent, the feed water passes through a system of heating tubes extending longitudinally in the smoke box casing, and the entire volume of exhaust steam passes through the casing, around the tubes, and thence to a nozzle in the smoke box from which it is discharged in the ordinary manner to the stack.

A feed-water heater which was tested on the Chicago, Milwaukee & St. Paul Ry. is described under the heading "Feed-water Heaters," in the "Report of the Committee on What is the Most Promising Direction in which to Effect a Reduction in Locomotive Fuel Consumption," appearing in the Proceedings of the Association of 1901. The committee states, preliminarily, that it looks upon using the exhaust steam from air pump and cylinders, "as being one of the most promising directions in which to effect a reduction in locomotive fuel consumption," and considers that a saving of 12 per cent in fuel would result.

Another appliance, known as the Brown feed-water heater, was installed on two locomotives of the C. M. & St. P. Ry. in 1908, and operated for some time on several divisions. This combined a tubular heater in the smoke box, surrounding the exhaust pipe, with a tubular casing on top of the boiler in which exhaust steam acted on the feed water. When operated under the care of the inventor it is stated to have shown a fuel saving of 4 or 5 per cent, but when put into pool service no appreciable saving was visible and it was abandoned after one test.

The Caille-Potonie feed water system, which is stated by its proprietors to be intended "for feeding locomotive boilers with water brought to a very high temperature by the partial condensation of the exhaust steam," has been applied to a considerable extent, and it appears, with very satisfactory results in Europe. A total of 245 locomotives having been fitted with it up to March 7, 1913, the first application having been made on the Chemin de Fer du Nord, France, in 1905. This system is stated to be covered by British patents. The reports of performance of the Caille-Potonie heater in Europe are very favorable. One that was made in 1913 by three English engineers, Messrs. Robert Steele, J. Johnstone Bourne and H. C. Powel, gives the results of four trial runs made on locomotives Nos. 3807,

3843, 3842 and 3803 of the Chemin de Fer du Nord, France. In their report they say that the pumps worked quietly and without shock, at about 35 double strokes per minute; that the comparison between the engines fitted with pumps, for cleanliness, leakage of water, etc., with those worked by injectors, "was most marked in favor of the pumps."

The Pittsburgh works of the American Locomotive Co. applied a feed-water heater to a 2-8-0 type locomotive which it built for the Lake Superior & Ishpeming Ry. in 1906. This heater was in the

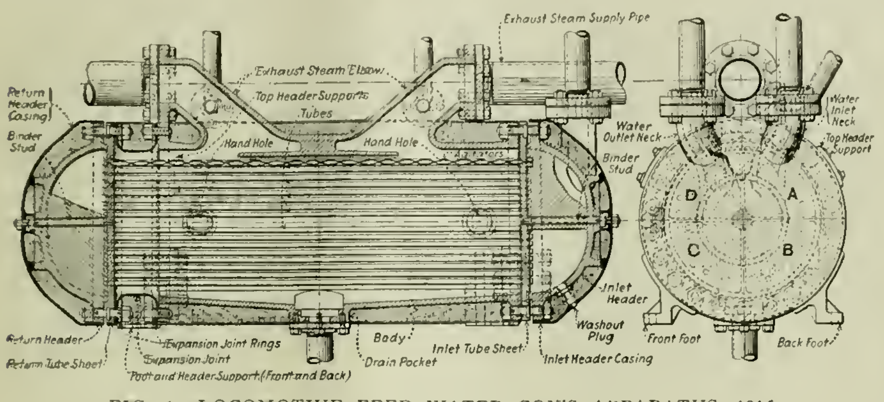


FIG. 4.—LOCOMOTIVE FEED WATER COY'S APPARATUS, 1916.

form of an annular water chamber, included between the wall of the smoke box and an inner sheet extending around its top and to a distance of 22 ins. below the center line of the boiler. This sheet was spaced 2 ins. from the smoke box wall, and boiler pressure in the chamber was sustained by 1-in. staybolts. No particulars of the water supply and discharge connections are available.

W. H. Richmond, M. M., Lake Superior & Ishpeming Ry. and Munising, Marquette & Southeastern Ry., reports that this heater was in use on the engine for about two years, but on account of application of superheater it was taken out. "The arrangement showed a good saving in coal and repairs to boiler," and the water entered the boiler at a temperature of 250 degs. Fahr.

A feed-water heater which was applied on four or five locomotives of the Central of Georgia Ry. in 1908. It was of the following construction: The exhaust steam from two 9½ ins. Westinghouse pumps and from a boilerfeed pump was passed through a preliminary tubular heater located on the running board of the locomotive, and originally a pipe was also led from one of the cylinder-exhaust passages to this heater. The water was pumped therefrom to a tubular heater in the smoke box, in the form of the Baldwin Locomotive Works superheater, and after passing through it was delivered through the regular check valve to the boiler. Tests which were run showed a fuel economy of practically about 15 per cent. As reported by F. F. Gaines, Superintendent of Motive Power, several objections were, however, found to this system, one being in the operation of the feed-water pump, which was later removed, and injectors used to force water through the whole system. The next objection was that it was found that very little use could be made of the exhaust steam from the cylinder passage. Finally, the feed-water units in the front end cut out very rapidly, by reason of the action of the sparks, in connection with the draft, and eventually the appliance was abandoned.

An exceptionally valuable and interesting paper, entitled "Some Effects of Superheating and Feed-water Heating on Locomotive Working," was presented by F. H. Trevithick and P. J. Cowan, at the meetings of the British Institution of Mechanical Engineers, and, with the discussion is published in the Proceedings, March-April, 1913. The views expressed in this paper as to the controlling principles and operative results of effective feed-water heating are fully applicable to designs other than those which it illustrates. It will be seen that the Trevithick & Cowan designs are based on the utili-

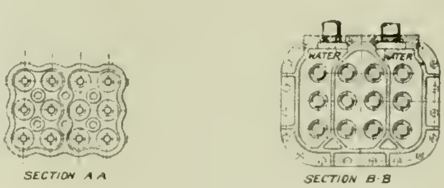


FIG. 5.

zation of the heat of the smoke-box gases and of the exhaust steam, and are similar in principle, and structural variations from that of M. N. Forney; also that they are similarly subject to the substantial objections of being bulky, imposing a large amount of weight on the truck, costly, both as to structure and maintenance, and involving an objectionable increase of smoke-box volume. The paper, however, alleged remarkable economies.

The Lovekin "film" feed-water heater, which was developed about six years ago, has been brought into successful and extensive application in marine and stationary practice. It is now being applied in locomotive service by the Locomotive Feed Water Heater Co. of New York. The heater member proper, which appears to be entirely novel in principle and structure, is here illustrated. In this system cold feed-water is drawn from the tender by a pump and forced through a tubular heater of the closed type, which is shown in Figs. 4 and 5. The water to be heated is forced through a set of narrow "film" spaces, each included between an inner and an outer corrugated tube, the pairs of tubes being so disposed in a casing that exhaust steam from the exhaust passages of the locomotive, as well as from the pump, passes around the outer corrugated tubes and through the inner ones. The arrangement of the pairs of corrugated tubes, one threaded inside the other in each pair, is such as to provide four passes for the feed-water, through the atmosphere of exhaust steam in the casing, from the last of which passes it goes directly to the boiler check valve. The principle upon which this heater is based is that of forcing the water, in thin layers or films, between surfaces of such form as to effect a high degree of agitation of the water and bring the agitated thin films of water into close contact with the exhaust steam. The object of the construction is to attain a high degree of heat transference in a compact apparatus, and to depend entirely upon heat that would otherwise be wasted, which is reclaimed in the heater, with a corresponding economy and increase of boiler capacity.

So far as the information of the writer extends, none of the different forms of feed-water heaters that have been applied in the United States, the earliest of which was that of Ross Winans on the Baltimore & Ohio Railroad in 1836, has been considered to be of sufficient advantage to be retained in operation, and none is believed to be now in service, except experimentally. The earlier designs have also been discarded in Europe, but there appears to have been in recent years a revival of interest there in the subject, and a considerable number of applications of the Caille-Potonie system and Weir have been made. There has been no variation of structural and operative principle in these from that of the early Winans heater, their essential elements being a tubular heater to which feed-water is supplied by a pump, and in which it is heated by exhaust steam. Various features of improvement in details have, of course, been added.

The feed-water heater of the future must, in the opinion of the writer, in order to be acceptable and advantageously applicable, be laid down on the general lines already stated and, as it seems to him, it is beyond question that such an appliance can and will be developed and adopted with the most substantial benefit in locomotive operation. Upon the basis

of the unquestionable advantage obtained in the long-established use of feed-water heaters in stationary and marine practice; the reported satisfactory results of their operation on European locomotives; the probable increase of advantage from their use in connection with the now practically universal application of superheating; and the views expressed by the large majority of the replies of members to the writer's circular of inquiry, conclusions, as to the question of the advisability of the application of feed-water heaters to locomotives, have been thus practically submitted for the consideration of the association.

Practical Hints on Valve Setting

Constant Tendency to Error Should Be Constantly Corrected

In an address delivered before the members of the International Railway Fuel Association at Chicago in the middle of the present year, Mr. Frank McManamy, governmental head of the Division of Locomotive Maintenance, and formerly Chief of the Federal Inspection of Locomotive Boilers, stated that in the matter of repairs to locomotives with a view towards reducing fuel consumption and improving locomotive performance the first in relative order of importance was setting the valves properly and maintaining the valve motion. Coincidentally we find that there are calls from locomotive constructors, for valve-setters, and while this detail of locomotive valve gear construction and repairs has always engaged the attention of the highest and best minds in the mechanical department, it would seem that in these days of a more resolute spirit of economy the subject is coming into a greater degree of prominence than usual, and rightly so, because while there is no longer any of that old-fashioned, stupid mystery in regard to the adjustment of the valve gear of a steam engine, every apprentice machinist engaged on locomotive work now having full opportunities for mastering the operation, it will be readily admitted by those who have ears to hear and heads to understand that the passionate exhaust of an overworked locomotive, especially of the heavy freight type, is seldom possessed of that exact, measured, regularly intermittent succession of blasts that it should have. There is a brevity or weakness in one or other of the four blasts that tells of organic disorder, but in the multiplicity of noises it is little heeded, or, if heard at all, it is seldom regarded and yet if the loss of steam, and incidentally of fuel, could be correctly calculated the figures would be startling, just as a constant leak in a domestic hydrant is looked upon by the busy domestic as being neither here nor there, as water is regarded as being as cheap as the intangible air. But that is another story.

It is easier, however, to discover a fault than to apply a remedy, and while it is not our intention at this time to enter into a scientific or practical description of the methods of adjusting the valve gear of the modern locomotive, a few hints in regard to its maintenance might not be out of place at this time. Admitting that the valves may be carefully adjusted in what is generally known as the back shop, a week's service on the road will develop inevitable variations. This should not be wondered at if we consider the blows of circumstance that have fallen upon the elastic and multiplex parts of the involved contrivance. It would be a marvel if it were otherwise, not only on account of the strains incident to the service, but more particularly on account of the variations in temperature, the original adjustment being invariably made while the locomotive was in a normal or cool condition, while the service and usually the examination of the gearing is made while the locomotive is in a heated condition. Usually this examination is seldom made by the same expert who originally adjusted the gear, but by a roundhouse authority who discovers that the wheel markings are not correct, as indeed they should not be expected to be under the charged conditions. Invariably the engine has dropped some distance on account of the relaxing of the springs, while the boiler has expanded in every direction carrying with it the quadrant, while little or no expansion has occurred in the reach rod and other parts of the gear. The readjustment is usually of a slipshod kind, the reach rod being rarely readjusted to the new conditions, while bearings that rarely all fit exactly may be rapidly wearing or adjusting themselves at some particular points. All tend to distort to a greater or less extent the exact opening and closing of the valves.

Admitting that these changes occur in the first week of service, it should not be imagined that a stationary or abiding condition has been arrived at, any more than one boiler washing will suffice for an indeterminate period. In brief, the regulations in regard to boiler washing at stated intervals could be worthily and well applied to the readjustment of the valve gear, with this variation in favor of the boiler, that with really pure water, if such a thing exists, the boiler can go a long time, while the exact adjustment of the valve gear is doomed to rapid distortion under any condition.

Again it must be admitted that under the best conditions both in exact construction and careful maintenance the contrivance, whatever form it may take, is never exactly correct. This should not be imputed as a fault either in the constructing engineer or in the skilled mechanic, but in the combination of forces passing through a variety of parts, no two of which are acting in the same plane, counteracting each other through a variety of loosening joints, all leading to error at the last delicate point where the opening and closing of the valve occurs. Hence it is well to have in particular regard the point of closure of the valve, or cut-off as it is called, wherever it may be, at which the engine, from the nature of the service, may be called upon to do its usually greatest amount of work. The full stroke of the valve is generally rarely used, and is not expected to be except in starting heavy loads, or on steep grades, and at such times the loss of steam under a comparatively high pressure is considerable, but usually of short duration. Hence it is of more importance than the points of cut-off should be as exact as possible, even if some sacrifice of the exact opening of the valve at each of the points of admission should necessarily be made to obtain an equality of the point of cut-off. These remarks refer more particularly to the Stephenson valve gear, which is more susceptible to distortion than the other gears now in use, but has the merit of being more easily rectified. It is generally admitted among leading experts that in the Stephenson gear, temporary adjustment of the eccentric rods from valve travel lines is generally made, and then cut-offs are taken, and, if necessary, final adjustment is made, whereas in the case of the Walschaerts gear, co-operation with the blacksmith, as far as the eccentric rod alteration is concerned, had better be done before taking the cut-offs to prove setting, even if a second alteration to eccentric rods is necessary to finally adjust cut-offs.

Again, it is not uncommon that in adjusting the intricate gearing, a real difficulty occurs at some particular point, and the question naturally arises in the mind—what does 1/64 signify? Perhaps it is inconsiderable in some instances when it stands alone, or if it remained at that limited figure, but the contrary is almost invariably the case. Error begets error. When the slightest negligence

occurs in the several parts of the same engine, it may happen by mere chance that the disregard of one small difference adds to each and every other variation, that the result becomes very marked when the locomotive goes into service, while on the valve stem marking nothing much out of the ideal may be noticeable. It should be remembered that trifles make perfection, but perfection is not a trifle.

One of the leading valve-setting experts of America, Mr. J. R. Britton, of the Canadian Pacific, pointed out to us that with an inside admission valve its valve stem expansion of 1/32 in. may be forgotten and the volume of piston rod at back end of cylinder may be neglected which together counts for a considerable distance in the cut-offs in many cases. When finding a dead centre the side play to piston crosshead and lost motion in main rod is very likely not considered. Driving horn binders not being tightened and driving axle box wedges being set up may be disregarded, thus allowing of an incorrect dead centre and even when dead centres are found, when in the act of catching one it may possibly be allowed to run by slightly and let go. The setting up of the driving wheels which occupy the rollers to the blue print distance from main frames on both sides during valve setting cuts some figure with the lead and the correct setting of the eccentric crank arms or sheaves, as the case may be.

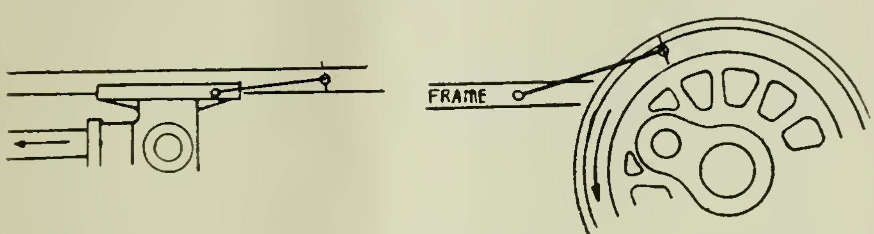


FIG. 1.

Striking a mean effect on lead and valve travels for a given change of reach rod of lifters amounts to something, but if this is neglected and again when measuring up lead on the valve stem reading, same is out 1/64 in. and is allowed to pass just because a 1/64 in. does not count for much, can it be wondered that a valve stem reading appears to be right, and when the locomotive gets into service it proves to be out of square?

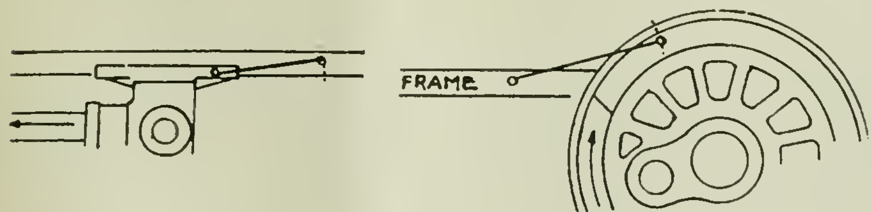


FIG. 2.

It may be added that the reference to the allowing a larger distance before the cut-off occurs in the back of the cylinder is of considerable importance, referring as it does in the case of a piston where the piston rod does not extend through the front cylinder head. In the case of the common single-ended piston rod, the variation in steam pressure, or, rather, the duration of high steam pressure, at the different ends of the piston can be readily determined by calculating the area of the piston rod and deducting it from the area of the piston. Thus, supposing the piston rod to be 5 ins. in diameter and the piston 25 ins. in diameter, their ratio of area being equal to the square of their diameters, the piston would occupy 1-25th of the space occupied by the piston. Hence if the point of cut-off on the front end of the piston stroke occurred at 6¼ ins., a distance of 6½ ins. at the back end of the stroke would equalize the amount of steam admitted at both ends of the stroke.

Furthermore, again referring to the securing of the dead center marks, the approved method of securing correct markings might well be emphasized by repeating a few of the directions recently issued by the American Locomotive Company: "Before locating the dead center tram marks check distance from top of frames to center of main wheels. If this distance is not exactly to figure given on erecting card, raise or lower the wheel to obtain the correct figure, checking both sides of engine. Revolve the wheel forward till crosshead is near end of stroke and make tram mark on outside face of the tire from center punch mark on frame, also tram mark on guide from center punch mark on crosshead. See Fig. 1. Revolve wheel forward till crosshead passes the first trammed position on return stroke, then revolve the wheel backward till tram from crosshead exactly matches the line on guide. Then make second tram mark on tire. By obtaining these marks in this manner errors due to looseness of main rod bearings are avoided. See Fig. 2. Draw line on tire parallel with outside edge and find exact center between

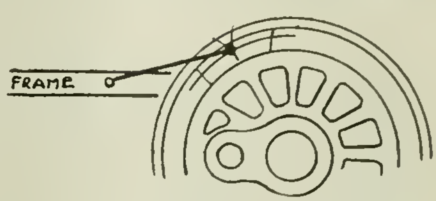


FIG. 3.

intersections of this line and the tram marks to obtain the point corresponding with exact dead center. See Fig. 3."

Dearborn Specialties.

The Dearborn Chemical Company have completed extensive experiments in the Dearborn laboratories, and are now marketing several of the products that are already meeting with much popular favor. Perhaps the most important of these is a rust preventative, known as No-Oxide, which is already in use in many plant making tools, and machinery, where it is essential or desirable to keep the metal parts, or the finely finished surfaces of the completed machines free from corroding, disfiguring rust, and certain Government departments have adopted it as the most efficient article on the market for the purpose.

Among other specialties developed are cutting oils, for use in metal cutting, to lubricate the cutting tool and prevent overheating; quenching oils, for heat treating, drawing oils, and what is known as Dearboline—a preparation for cleansing machined parts of emery or grease.

The research department of the Dearborn laboratories has devoted three or four years to the development and testing of these specialties, working along scientific lines in this, as they have always done in the manufacture and sale of their widely known water treating preparations, and in these days of greater efficiency the admirable work of the enterprising company cannot fail to meet with a full measure of recognition and encouragement.

Service.

We are living in conservative times. We are familiar with the command to save wheat, save meat, save daylight, save everything and help win the war. Now let us, as railroad men, as soldiers, if you please, in the railroad branch of the government service, save men. Every man serving a railroad is serving Pershing's guns. Every train that moves is a part of the army and navy supply force as truly as if it were only ten miles behind the first line trench.

In a certain way we are all soldiers, and if we sleep at our posts we should not be allowed to live.

Pacific Type Locomotive for the Atlantic Coast Line

The Atlantic Coast Line has recently received from the Baldwin Locomotive Works, of Philadelphia, a number of Pacific, or 4-6-2, type locomotives, which are designated as Class P-4 on the railroad. These mark the latest development of an interesting series of passenger locomotives, which have been doing excellent work on the A. C. L. Compared with their immediate predecessors, Class P-3, on that road, they show increases in weight and capacity as follows: Increase in weight on drivers, 7.5 per cent; increase in total weight, 7.5 per cent; increase in tractive force, 9.0 per cent; increase in water heating surface, 27 per cent; increase in superheating surface, 51 per cent.

Although the main line of the Atlantic Coast Line has comparatively easy grades and curves, these locomotives are called upon to do some exceedingly trying work. Especially during the Florida tourist season, passenger traffic becomes very heavy, and 12-car steel trains must be hauled on exacting schedules. The line also handles a large amount of perishable freight, which is moved on fast schedules. The weight on drivers is limited to an amount that can be safely carried on 85-lb. rails, and in view of this, a most satisfactory design of locomotive has been produced.

Comparing Classes P-3 and P-4, according to the nomenclature used on this railway, it is evident that the additional weight of the newer engine has been utilized chiefly in providing a larger boiler. The diameter of the shell at the first ring has been increased 10 ins., and the result is a marked increase in the sustained horsepower capacity of the locomotive. At the same time, the cylinder diameter has been increased from 22 to 23 ins. With a tractive force of 37,000 lbs., and a weight on the drivers of 151,050 lbs., Class P-4 has a ratio of adhesion of 4.09. Although the driving wheels are of moderate size, their diameter is ample for the requirements of the service. The same sized wheels, 68 ins., are used on these engines as on engines of Class P-3.

The firebox has a combustion chamber 24 ins. long, and in order to provide a water space of ample depth under this chamber, a conical ring is placed in the middle of the barrel. In accordance with Atlantic Coast Line practice, all the iary drifting valve.

The valve motion is of the Walschaerts type controlled, in the case of the locomotive illustrated, by the Lewis power reverse gear. Some of these locomotives are equipped with the Ragonnet power reverse gear. The valves are set with a lead of ¼ in. Gun iron is used for the cylinder and steam chest bushings, the piston heads, and the piston and valve packing rings. The piston rings are of the Dunbar type, and are set out against the cylinder walls by means of springs.

The main frames are .40 carbon steel castings, annealed. In place of the usual rear frames, which have separate cross-ties, spring hanger brackets, footplate, etc., bolted to them, the Commonwealth rear frame cradle is used, and all these separate pieces are combined in a single casting. The rear truck is of the well-known Hodges type. Double refined wrought iron is used for the equalizing beams and spring hangers, and all pin-holes in the spring rigging are bushed. The spring rigging is cross-equalized between the rear drivers and trailing truck.

The tender has a one-piece, cast steel frame. The fuel and water capacities are 12 tons coal, and 8,000 gallons water, respectively.

Further particulars of these locomotives are given in the table of dimensions which we here append.

Gauge of track, 4 ft. 8½ ins.; cylinders, 23 x 28 ins.; valves, piston, 14 ins. diam.

Boiler—Type, conical; diameter, 76 ins.; thickness of sheets, ¾ in., 13/16 in., ⅞ in.; working pressure, 200 lbs.; fuel, soft coal; staying, radial.

Firebox — Material, steel; length, 108 1/16 ins.; width, 75¼ ins.; depth, front, 82¾ ins.; depth, back, 74¼ ins.; thickness of sheets, sides, ⅜ in.; thickness of sheets ⅜ in.; crown, ⅜ in.; tube, ½ in.

Water Space—Front, 5 ins.; sides and back, 4½ ins. Tubes—Diameter, 5⅜ ins. and 2 ins.; material, 5⅜ ins. steel, 2 ins. iron; thickness, 5⅜ ins. No. 9 W. G., 2 ins. No. 11 W. G.; number, 5⅜ ins. 36, 2 ins., 227; length, 18 ft. 2 ins.

Heating Surface—Fire box, 208 sq. ft.; combustion chamber, 46 sq. ft.; tubes, 3,065 sq. ft.; firebrick tubes, 26 sq. ft.; total, 3,345 sq. ft.; superheater, 792 sq. ft.; grate area, 56.5 sq. ft.

Driving Wheels — Diameter, outside, 68 ins.; diameter, center, 62 ins.; journals, main, 10½ ins. x 20 ins.; journals, others, 9½ ins. x 12 ins.

Engine Truck Wheels — Diameter, front, 31⅜ ins.; journals, 6 ins. x 10½ ins.; diameter, back, 44 ins.; journals, 8 ins. x 14 ins.

Wheel Base—Driving, 13 ins.; rigid, 13 ins.; total engine, 33 ft.; total engine and tender, 67 ft. 2¼ ins.

Weight—On driving wheels, 151,050 lbs.; on truck, front, 51,700 lbs.; on truck, back, 41,100 lbs.; total engine, 243,850 lbs.; total engine and tender, 402,700 lbs.

Tender—Wheels, diameter, 36 ins.; journals, 6 ins. x 11 ins.; tank capacity, 8,000 U. S. gals.; fuel capacity, 12 tons; service, passenger.

ATLANTIC COAST LINE RAILROAD 4-6-2.

R. E. Smith, Genl. Supt. Motive Power. Baldwin Loco. Wks., Builders.

The Fourth Liberty Loan campaign will begin Saturday, September 28, and close October 19. No American doubts its success; no good American will fail to contribute to its success. The blood of our men fallen in Europe calls to us; our answer must be and will be worthy of them and our country. It becomes us all not only to do all that we should do, but to make others do all that they can.

The Advance of Science Applied to Locomotives in the Last Eighteen Years

Mr. H. B. Oatley, chief engineer of the Locomotive Superheater Company of New York, spoke at a recent meeting of the American Society of Mechanical Engineers, on the relative economy of the locomotive, as it was in 1900, and as it is today. Dealing with this interesting comparison, he said among other things: "A substantial advance has been made during the past eighteen years, in the development of the locomotive. When viewed in its broadest sense the question may fairly be answered by the statement that the locomotive of today is at least 50 per cent more effective than the locomotive of 1900. The leading factors that produce this result are: (a) Adoption of highly superheated steam; (b) increase in size of locomotives; (c) more positive control of mechanical operation and better steam distribution; (d) improved combustion; (e) increased average speed while hauling trains; (f) increase in the percentage of time available for revenue earning service.

Fuel economies through the use of highly superheated steam of not less than 20 per cent in all class of service, have been demonstrated, and are unanimously accepted by railroad men. The fact that today over 21,800 locomotives, out of a total of approximately 65,000 that are in service on American railroads, are using superheated steam is emphasized by realizing that over 95 per cent of the steam locomotives built during the past five years have been thus fitted, and this is taken as proof of the advantages to be obtained by the use of superheated steam. The adoption of highly superheated steam by the United States Railway Administration engines now under construction is a very strong endorsement of the system. When these facts are considered and it is realized that figures as low as 2 lbs. of coal per i.h.p. hour have been obtained on engines using highly superheated steam and that in general road operation, under all conditions of weather, a figure of 3 lbs. of coal per i.h.p. hour is obtained, it is particularly difficult to accept as accurate a recently published statement attributed to Mr. E. W. Rice in his argument for the electrification of steam roads, in which he says, "At least 6 lbs. of coal is required per horsepower hour for the work performed on steam locomotives." Such a statement is unfair to the railroads in this country, and should have been accompanied by supporting data.

The increase in the size of locomotives during the past decade and a half is strikingly shown by the comparisons of locomotives given in the following tables:

TABLE NO. 1—PASSENGER SERVICE.

Year built	1900	1905	1918	1918
Type of engine ...	460	462	462	482
Road	L.S.&M.S.	B. & O.	U.S.Std.	U.S.Std.
Total weight	171,600	229,500	300,000	350,000
Weight on drivers	133,000	150,500	180,000	240,000
Cylinders	20x28 ins.	22 in. x 28 ins.	27 ins. x 28 ins.	28 ins. x 30 ins.
Wheels, in inches..	80 ins.	74 ins.	79 ins.	69 ins.
Boiler pressure ...	24,990	35,000	43,800	58,000
Max. I. H. P......	1,398	1,816	2,624	2,824
Fuel	Bit	Bit	Bit	Bit
Brick arch	No	No	Yes	Yes
Superheater	No	No	Yes	Yes

TABLE NO. 2—FREIGHT SERVICE.

Year built	1900	1917	1918.	1918
Type of engine ...	280	230	282	2-10-2
Road	I.C.R.R.	D. & H.	U.S.Std.	U.S. Std.
Total weight	216,000	297,000	322,000	390,000
Weight on drivers	196,000	266,000	240,000	300,000
Cylinders	23 ins. x 30 ins.	27 ins. x 32 ins.	27 ins. x 32 ins.	30 x 32 ins.
Wheels in inches ..	57 ins.	63 ins.	63 ins.	63 ins.
Boiler pressure ...	210	210	190	190
Tractive power ...	49,690	66,000	60,000	74,000
Max. I. H. P.....	1,853	2,755	2,493	3,082
Fuel	Bit	Pulverized fuel	Bit	Bit
Brick arch	No	Yes	Yes	Yes
Superheater	No	Yes	Yes	Yes

TABLE NO. 3—PUSHER SERVICE.

Year built	1903	1918	1918
Type of engine	0660	2,882	2-10-10-2
Road	B. & O.	U.S.Std.	Virginian
Total weight	334,500	540,000	684,000
Weight on drivers............	334,500	480,000	617,000
Cylinders	20x32x32 ins.	25x39x32 ins	30&48x32 ins.
Wheels in inches	56 ins.	57 ins.	56 ins.
Boiler pressure	235	240	215
Tractive power	71,300	101,000	147,000
Max. I. H. P..................	2,450	3,725	5,030
Fuel	Bit	Bit	Bit
Brick arch	No	Yes	Yes
Superheater	No	Yes	Yes

The Consolidation engine of 1900 and of 1918, illustrates the growth of a type of engine which would not have been possible, economically, had it not been for the successful solution of the problems of superheating, improved steam distribution, mechanical stokers, feed water heating, the use of pulverized fuel, large fire-box volume and the increased knowledge of boiler design which permitted the successful combination of these devices on one engine. The same conditions are responsible for the growth in the 4-6-2, or Pacific type of passenger locomotive, as well as in the 2-8-2 or Mikado type and the 2-10-2 type engines, which have had a rapid development and wide adoption during the better part of the period 1900-1918. There are now over 5,000 of the Mikado, or 2-8-2, type of locomotives that have been placed in service during the past eight years, and over 900 of the 2-10-2 type. Over 4,000 Pacific type engines have been built since 1910. All of these have been fitted to use superheated steam, and a very large proportion of them have been equipped with water tubes in the fire-box, which are used in combination with the fire-brick arch.

The growth in size of the Mallet or articulated locomotive is well illustrated by a comparison between the first 0-6-6-0 engine built for road service in 1903 and the maximum-sized 2-10-10-2 articulated engine now in service on the

Virginian Railway. The increase in the size of the locomotive has been a great factor in cutting down the various costs of transportation, by permitting not only increases in the average weight of trains, but in the incidental advantages accompanying greater train loads, particularly with respect to increasing the capacity of single track roads. It is interesting to note that the average tractive power of all engines operating in the United States in 1900 was 17,000 lbs. In 1918 it had increased to 36,000 lbs., or 126 per cent.

Improved conditions of combustion have been brought about by the study and development of adequate air openings in ash pan and through grates, proper proportioning of combustion chambers, the extended use of water-tubes and fire-brick arches, greater knowledge as to the proper length and diameters of boiler tubes, and incidentally better design of, and closer attention to, the front end draft appliances. Full credit should also be given, in this particular, to the efforts on the part of the railroad mechanical officers in the instruction of firemen and enginemen in the proper firing and handling of engines. These efforts have shown excellent results in eliminating fuel loss from tanks, at coaling stations and in the handling of the coal on the locomotive. The present interest in feed water heating is commendable, and advantageous results have been demonstrated.

Greater average speed over the road has resulted from the building of locomotives of greater power and efficiency, as well as from better knowledge of the proper rating of engines. Overloaded locomotives, which are stalled in bad weather or on the ruling grade, are today exceptional. Twenty years ago they were of very frequent occurrence. The annual report for 1917 of the Illinois Central contains a striking illustration of the increase in train loads made possible by the development of the present-day locomotive. In 1908 on this road the average train load per revenue train mile was slightly under 410 tons. In 1917 it was approximately 700 tons (more than 70 per cent inercase in *nine* years.) Locomotives of the present date are in revenue-earning work a longer part of the time than was the case at the beginning of the present century. Greater efforts on the part of the mechanical organizations to keep locomotives ready for service have contributed toward this improvement. The progress in design of locomotive and tender parts subject to wear and consequent removal have latterly caused the introduction of details which help the engines to make greater mileage between shoppings, and this fact contributes to increase in hours per day that the locomotive is in service.

The above are a few of the principal causes for the conclusion stated in the above paragraphs, which is that the present day locomotive may conservatively be stated as not less than 50 per cent more effective than the locomotive of 1900. This very gratifying result can be credited, not to any one group of men, but to the energy of railroad mechanical officers, also to locomotive builders and to the engineering organizations which have specialized and developed various devices that are incorporated in the present-day practice.

In 1917 a statement was made by the general superintendent of motive power of a prominent road, in which he said, "All of this shows that during the last five years the economy and capacity of our locomotives has been more than doubled, and this has been obtained for an investment in property, insofar as the cost of the locomotives is concerned, that will not amount to a 30 per cent increase." If this is the condition on one road covering a five-year period, it ought certainly to be accepted as applicable to the railroads of the country over an eighteen-year period. Promise for future development, probably as noteworthy during the next generation as during the past, will come from the efforts being steadily made along the following lines: 1. Increase in steam pressure. 2. Greater boiler capacity. 3. Higher degrees of superheat. 4. Extension of the use of feed water heating. 5. Increased use and improvement in methods of burning powdered or pulverized fuel. 6. Modification in engine design to produce higher thermal efficiency. 7. Adoption of steam-electric self-contained units. 8. The adoption of condensing operation for the engine.

It is realized that a prophet usually treads on uncertain ground, but considerable thought has been given, and noticeable progress has been made at the present time, which gives us confidence to make the above statement. No one who is familiar with the subject of the steam locomotive will contend that the present development represents the maximum that is yet obtainable, and it is not over optimism to believe that, at least equal progress will be made in the next eighteen years as has been made since 1900.

Goggles More Than Protective

By W. T. POWER, M.A., M.D., NEW YORK

Public Health officials and the medical profession generally have contributed their share of good work in directing attention to the occupational diseases and to the unnecessarily great number of accidents, maiming, disfiguring, and even fatal. It has been shown that by careful attention to the details of environment, ventilation, illumination, hours of work and such conditions coupled with safeguards adapted to each industry, a surprising amount of occupational disease can be abolished and more than fifty per cent of the accidents formerly considered unavoidable, may be prevented.

It has been demonstrated that these things pay. Not alone in the physical well-being of the worker, not alone in the mental satisfaction of the employer, but financially. It also pays in the increased productivity of the worker and in the obviating of legal expenses resulting from settling for such injuries and diseases. From all this arises the eminently successful "Safety First" movement. It would be difficult to exaggerate the good accomplished by the widespread adoption of the spirit of this movement.

I refer to the eyes of industrial workers. In making this statement, I recognize fully the fact that much has been done to improve lighting conditions and that devices have been adopted and rules promulgated to offset the danger to the eyes from flying missiles. I am not unmindful that carefully constructed goggles are in general use to protect the eyes of the wearer from injury by violence. I am also aware that colored glasses have been devised to safeguard the eyes from the baneful effects of ultra-violet and other injurious rays and from the glare of incandescence, and other menaces to the sight of the workers; but one phase of the subject has so far received scant attention and that is the presence of refractive errors in the eyes of the worker.

The great benefit derived from the examination of the eyes of school children and the correction of their refractive errors are familiar to all. The improvement in vision, the abating of nerve irritation by the relief of eye strain and the resultant sense of general well-being bring about a greater capacity for work.

The manifestations of eye strain are numerous. They range from simple squint and from headache to severe nervous conditions and mental disturbance. At first, eye strain may cause simply fatigue after a short time at reading, sewing, writing or other use of the eyes at short range. It may cause drowsiness or

simply disinclination for further near work. It may cause a watering of the eyes, redness of eyeball or edges of the eyelids. It may give rise to headache of almost any character. Many cases of vertigo, so-called sick headache or "bilious attacks," are caused by eye strain.

As the great mass of workers is recruited from the ranks of foreign and native born individuals whose educational opportunities have not been great, they may be said to be in practically total ignorance of the handicap imposed by refractive errors in the eye. The average manual laborer is of the opinion that glasses are quite proper for the office man and the man of education and refinement to use, but for him to wear glasses would be a confession of weakness or affectation because they do not belong to his sphere of existence.

All unknown to the individual himself, errors of refraction are of very frequent occurrence among industrial workers. The consequence of this is not alone the resultant inaccuracy of vision, but all the concomitant distressful symptoms of eye strain. That this is a serious handicap to the comfort and physical well-being of the worker as well as a bar to his efficiency and advancement.

The first step in the desired direction must be to educate the workers to maintain a receptive condition of mind. The employer must be taught to recognize the fact that his presbyopic workman is no more unfitted for his exacting fine work by the correction of his presbyopia than is he himself unfitted for conducting the business of his office because he must wear presbyopic correction glasses to read his letters. And the workman must learn that his employer has come to think that way. Presbyoptic is the scientific name for long sightedness, together with the diminishing power to distinguish things near at hand. This is a condition common to the approach of old age. The worker may be practically unconscious of it, but its effects persist. The way has been prepared by the widespread use of protective goggles which fortunately can be ground to prescription.

If we are going to put goggles on the workingman, let us see that those goggles not alone do him no injury, but that in them he receives all the benefits that scientific skill can devise.

In the past there were three main reasons why the workingman did not wear glasses. First—A lingering prejudice founded in a belief that the wearing of glasses was an affectation of elegance or style that did not belong to his walk of life. Second—Ignorance of what constitutes eye strain and the benefits to be derived from properly fitted glasses. Third—Fear of injury to his eyes from the breaking of lenses. This fear shared in by his employer who preferred men who did not wear glasses. The last was probably the most potent reason of all. The protecting goggle has done away with all of these barriers. Now that ground goggles have so demonstrated their efficiency that they are a feature of industrial equipment; now while they are comparatively new and while their use is beginning to spread so that the time is not far distant when every man whose eyes are even remotely endangered by his employment, will be required to wear them; now is the time to advocate that when goggles are being fitted that the vision should be tested and the goggle utilized to correct all errors of refraction.

When we consider the thousands or perhaps hundreds of thousands of workmen now equipped with protective goggles, the thought arises that peering through these lenses, there must be an infinite variety of eyes. There are undoubtedly among them numerous examples of every abnormal or anomalous condition to which human eyes are subject. There are of course many normal eyes, but there must be also many eyes afflicted with varying degrees of heterophoria, latent or manifest, fundus diseases of every description and every variety of corneal and lid affection. The disease called heterophoria is simply failure of accommodation, or the ability of the eye to quickly change from long to short sight with all intermediate adjustments. It is caused by insufficient action of one or more muscles of the eye. Some of the fundus diseases result in the retaining in the eye the image previously looked at long and intently, and the corneal affections concern the outer covering of the ball of the eye.

It would seem but a part of wisdom to critically examine the goggles and determine whether or not they may contain any subtle or hidden influence for harm.

It goes without saying that the lenses must be made of tough glass capable of resisting great violence, that if the impact be great enough to cause the lens to break that the fragments will not enter the eyes of the wearer. The lens must be clear, transparent and be of such size, shape and so positioned as to give a wide, unobstructed field of vision. That it must not distort, magnify nor minimize the objects looked at.

These requirements are obvious and are of course essential to the success of any goggle on the market. But there is a defect which may be present in lenses which will fulfil all the requirements so far enumerated, a defect not apparent to the wearer and not readily detected except by most accurate and expert examination, and that is the presence in the lens of a prism of low degree. The lens may have a smooth surface and appear perfect, but if one segment of the circumference is ever so slightly thicker than the rest of the circumference, then that lens is a prism. The unintentional presence of such a prism is capable of working great harm to the wearer.

Just as therapeutically a prism may be utilized to restore the muscular balance in an eye afflicted with heterophoria, or old age sight, so a prism placed before the eye in which the muscular balance is normal will throw out of balance the muscle over which its influence is exerted. If the wearer had already a latent heterophoria, the prism would tend to aggrevate this condition, unless by sheer good luck the base of the prism should chance to fall into a position favorable to the weak muscle. The healthy, robust individual can frequently accomplish a wide range of accommodative effort, even successfully compensating for high degrees of refractive error with little or no inconvenience. Yet this forcing of the refractive media of the eyeball to overcome its defects, always taxes the delicate ciliary or eye-lid muscle, and in those not sufficiently robust to endure it, eye strain is the result.

These protective goggles have accomplished so much in the saving of human eyes that it is well to make them more perfect and to eliminate any possibility of harmful affects from their use. This can be done by rigid examination of every lens by a delicately adjusted instrument capable of detecting the slightest variation in the thickness of the glass.

If we could bring about conditions whereby every individual who is required to wear protective goggles would have his vision tested and corrected by the goggles, the benefits derived would be such an object lesson to employers and employees that it would lead in the near future to the correction of refractive errors of all workers whether their eyes were exposed to injury by violence or not. This is an ideal well worthy of the medical profession and its accomplishment a great and important step in the direction of the conservation of vision and the benefiting of the individual worker. In the aggregate it would tend to increased industrial activity and increased efficiency.

Painting Iron Structures

Iron structures should be painted while their scale is still on, after loosely adherent flakes and rust have been scraped off. The paint will last rather longer than if applied to the pickled or sand-blasted surface, and the labor of removing the scale is saved. The very best results are obtained by multiple coats. Two thin coats are better than one thick one of equal weight.

Quebec Bridge

The Quebec bridge over the St. Lawrence River, which collapsed twice during the course of construction, passed its final test when two trains weighing 7,000 tons were run out on the central span.

The Flow of Metal

The expression, "the flow of solid metal," would ordinarily strike one as anomalous. We have seen bronze statues retain their shape from generation to generation, and we have somehow come to believe that hot metal in the liquid form is the only state it can exist in and flow. In fact, we usually think of the flow of water only when it is in the liquid form. Nature gives us so many streams and rivulets, that the idea is easily superficially confirmed. But for all that, it is not entirely true. An early Alpine explorer, Hugi, in 1827, found that a little hut built on the glacier called Untezaar, at the foot of a great promontory, had most distinctly moved with the flow of the solid, and as poets call it, the eternal snow.

In 1830 the hut was 110 yds. lower down the slope than where it had been built. In 1836 it had travelled 780 yds. and by 1841 it had reached a distance of 1561 yds. from its original position. Its average movement had been at the rate of about 112 yds. a year. The measurements, by

ORDINARILY SHAPED HEAD OF RIVET SHOWING THE HOLE NOT QUITE FILLED.

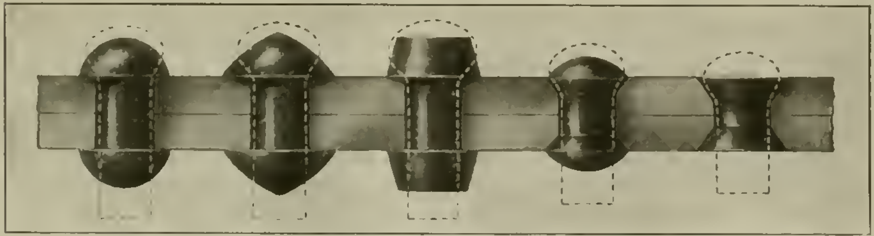
our own scientific men, like Agassiz, confirmed the truth of the slow movement of so solid, so unyielding and so firm a thing as the ice-cap of the eternal mountains. Various movements have been observed, and "stationary" marks that have been shown to have shifted their positions from 52 to 89 yds. and others from 36 to 81 yds., but at whatever speed the ice flow may have had, it remains in the form of solid matter, and moves on with irresistible force to the terminal moraine, from under which a turbid river has its origin.

The flow of solid metal has been shown by the "splash" of steel armor plate when struck by an "A. P." projectile, fired from one of our large high-power coast-defence guns. The target exhibits, after the impact of the projectile, the stage of a "frozen" splash. These phenomena speak to those who are inclined to hear of the "oneness" of matter, and we are not surprised to hear that an enterprising commercial firm, the American Flexible Bolt Co., have turned this piece of universal knowledge to good effect.

AMERICAN FLEXIBLE BOLT CO.'S NEW RIVET.

This company says, with every appearance of truth, that they have by employing the principle which we have just emphasized, evolved a thoroughly tight, strong rivet, in which most of the laborious and often uncertain work of caulking is eliminated. The rivet we speak of has a pear-shaped head, which allows it to fit the hole in any set of plates. The pear-shaped head which it has, being equally useful where a snap head or a countersunk rivet is needed, and all intermediate forms may be sought, and handled by the same make of rivet.

By using a rivet of this kind, not only is caulking brought to its lowest terms, but the stock of various forms is reduced. The one kind of rivet is equally applicable to any and all the kinds of rivet sizes used in locomotive boiler work. As to the matter of cost it has not risen in price, because it is simple in design and as easy or rather easier than usual for the manufacturer to make, as he has but one form to adhere to. In using this rivet no difference in appliances or in methods are required in the shop. Anyone who can use a rivet can use the product of the American Flexible Bolt Co. It fits any hole, and readily accommodates itself to the work it is expected to do.



STYLES OF HEADS WHICH CAN BE MADE WITH THE NEW RIVET WITH THE BULB-SHAPED HEAD.

The flowing of the metal is really the primary cause of the other advantages, such as the practical reduction of the work of caulking, the elimination of odd sizes, and the settlement on a most satisfactory basis of the cost. An ordinary rivet, when it has to be removed, has its original head cut off, and it is then backed out by a punch and flogging hammer. The reason it is "backed out" is because at the end of the rivet where the "made" head is situated the metal has showed signs of flowing, and tightly filling the hole under the influence of the forming hammer. Caulking is not usually applied to the "made" head, and the metal below the permanent head has not shown any tendency to flow or tightly fill the hole. The "American" rivet with its hot pear-shaped head forces the stalk of the rivet immediately under it to flow, and so fully, completely, and tightly fill the hole.

This is due to the fact that to begin with the pear-shaped head does not fit at all, but being plastic, when hot, yet retaining its fibrous structure and the other qualities which give metals their virtues in our eyes, it follows the law of Nature and acts as if it were to all intents and purposes a liquid, while it is really a solid of high grade, and it fills the hole at both ends, as it "upsets" equally from either end, at the time it is hammered down to place.

The flowing of the solid ice-cap on the mountains, the splash of the dense, resisting steel, when subjected to the penetration of the whirling projectile, are as truly due to dumb obedience to the inflexible laws of Nature, as are the splash of a drop, the dent of a thrown pebble in the soft sand, or the "freezing" of a stalactite in the Mammoth Cave. The application of this law to the uses of man in one of his noblest enterprises—Transportation—is giving him one more lever to lift himself to a higher plane, by adding a part to the safety and efficiency of boiler construction, at practically no increase in cost. This is a matter that is well worthy the attention of all.

The Norfolk & Western has placed a contract with the Roberts & Schaefer Company, engineers and contractors, Chicago, for the complete designing and building of a large 1,200-ton capacity, six-track automatic electric, reinforced concrete locomotive coaling plant. This structure will be equipped with a concrete "RandS" gravity sand plant, using Beamer patent steam and sand dryers, and duplicate hoisting and distributing coal equipment.

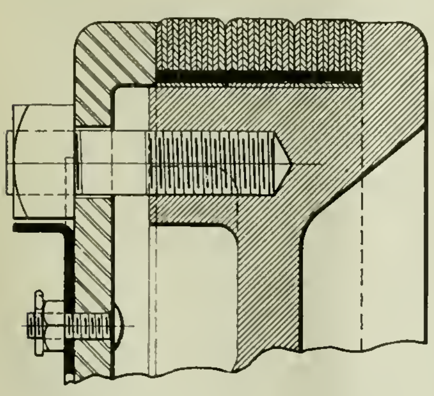
Pledge yourself to save to the utmost and to buy a definite amount of War Savings Stamps.

Bad Substitutes for Piston Packing for Small Cylinders

One of the "diseases" which is more or less chronic on railways at supply stations is being "out" of certain articles which should always be in stock. This "disease" occasionally reaches the acute stage and makeshifts of various kinds have to be resorted to in order to meet the emergency. Take for example piston packing, particularly that used in air brake and Ragonnet cylinder work. In some cases pieces of bell cord, frayed rope and even suspenders have been made to do duty instead of properly made packing.

Ragonnet reverse gear cylinders are operated by air, though there is an emergency connection for steam in case the air gave out. The kind of packing which is recommended for this gear is a rubber fibre packing, and this has been adopted because road engines pulling approximately nearly equal loads day after day, cause the piston to move within very narrow limits, and what wear does take place on the cylinder walls causes the gradual formation of a "hump," which the piston, when traveling full stroke, is forced to negotiate by the aid of what "give" there is in packing rings.

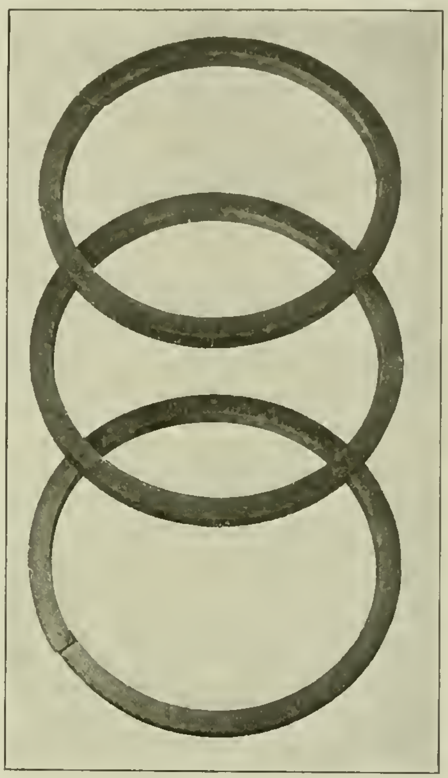
Under these conditions it has been found that rubber fibre packing permits the formation of the "hump" to be so long delayed as to be almost a negligible quantity. The form of the packing is interesting as a means of solving the problem. It consists of a piston with space turned on the rim, capable of containing a "bull-ring." With the rubber fibre packing the bull-ring is not necessary, the space being neatly occupied by the square-section rings of prepared rubber fibre. These rings are soft enough to be squeezed by the firm pressure of the hand, and they stand on a strip of flat red-rubber which



PREPARED RUBBER PACKING.

has specially been prepared so as to resist the action of air, steam or hot water.

In order to keep this packing tight and hold it in place, a follower plate has been applied, with a "take up" in the form of a flange which projects over the place where the bull-ring usually goes, and by screwing up the holding bolts a pressure is exerted on the rings and flat strip of red rubber. The compression of the red rubber strip by the action of the follower plate has a tendency to bow it up under



RUBBER PACKING RINGS.

the rubber fibre rings, and this forces them outward against the cylinder walls and so keeps them tight. The rubber of which the rings are composed is, so to speak, "impregnated" or closely associated with fibre which is a suitable texture of some kind, and holds the piston tight with very little tendency to allow a hump to form. The red rubber strip rests on a thin layer of rubber fibre, so that it will not stick to the metal of the piston.

It is easy to see that the substitution for this efficient packing, of pieces of torn-up overalls, bell cord, waste or even the otherwise useful human suspender, cannot make for economy. The scrap packing may not encourage the formation of a hump, but it does not keep tight very long and the pieces of dirt and grit which invariably coat its surface have a tendency to increase friction, uselessly use up oil, and may score or scratch the cylinder walls.

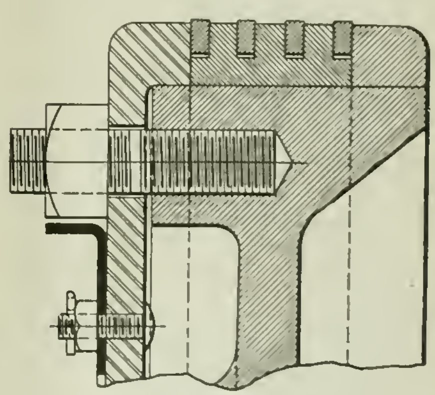
The Government engines are, however, supplied on special order with metallic packing which requires the use of a bull-ring. The metallic rings are bored eccentrically and are made very thin, like those used in automobile engines, and, of course, these rings are held out by air pressure or by steam when that is used in case of an emergency.

A difficulty presents itself here as it does with all cylinders which are horizontal, and that is the difficulty of proper lubrication. It is easy enough to keep the bottom supplied with oil, but the top does not readily hold it. The company recommends that on wash-out days the cylinder heads be taken off and the pistons withdrawn and the cylinder walls be rubbed with grease.

Increase of Wages.

By C. Richardson, Bridgeport, Conn.

The admirable editorial in last month's Railway and Locomotive Engineering on the "Increase of Wages for Shopmen" hits the nail on the head. The meager rate of wages at which railroad machinists and other mechanics have been working for many years was a reproach to the service, and the Government administration has done well in making a liberal increase in the remuneration to the skilled artisans who have been overlooked in the general trend of increased wages. The high prices of commodities and the advanced cost of living have been realized by the Government, and not only have they performed an act of justice to the artisan, but they have shown their appreciation of the really reduced purchasing power of the dollar, in a most practical and satisfactory way. These things have made it imperative that something in this way should be done, but in other years, perhaps not so particularly marked as the present war period, nobody seemed to have thought of the railroad mechanic.



STYLE OF METALIC PACKING USED.

Building union, and brotherhood men, quite useful in their line, were comparatively well off The railway machinists' horny hands were never sheathed in gloves except to resist the shock of electric batteries or to withstand the heated firebox bricks.

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Electrical Test of Coal.

The comparative value of different kinds of coal, as far as their steam-producing qualities are concerned is ably dealt with by Mr. Samuel Cohen in the Electrical Experimenter. For many years, people of a scientific turn of mind, though not experts, have been anxious to find an easy, expeditious, and comparatively cheap way of getting at a working basis of comparison, between fuels of more or less heating value. The electrical test applied to coal, appears to be at least an approximation to what many would like to have.

When we come to make the test, the writer points out, we must consider five important points. These are, the amount of moisture, volatile combustible matter, percentage of ash, sulphur, and calorific value. The latter is the one in which we are interested. Electricity plays a very important role in the determination of the last while the first four items are de-temperature of 212 degrees Fahr.

The analysis of the coal is very thorough, yet it is simple, and an idea of the heating value is secured. Anthracite coals are characterized by a small percentage of volatile combustible matter (usually less than 10 per cent), while bituminous coal contains a large amount of this volatile constituent (usually 30 to 40 per cent). In cannel coal this is the main constituent. The proportion of volatile matter is dependent on the amount of hydrogen present, as hydrogen forms volatile compounds with carbon. When hydrogen burns, it evolves a much larger amount of heat than is produced by the combustion of the same amount of carbon.

Among the direct methods of getting at the calorific value of coal, the method by which a calorimeter is used seems to be highly satisfactory. The calorimeter is made up of a combustion chamber, a tank of water with a delicate thermometer for indicating the amount of heat absorbed, and an insulating device to prevent the external heat from reaching the water and the thermometer, and also to prevent the heat generated in the combustion chamber from escaping from the apparatus.

The temperature of the coal when burning is determined by means of an electric thermometer which is inserted in the coal chamber. This thermometer is a fine high-resistance wire, whose resistance is determined at the beginning of the test and at the period of combustion. The resistance increases as the temperature rises, and as there is a definite relation between temperature and resistance, it is possible to determine the temperature corresponding to the resistance. By measuring the resistance of the wire in the coal chamber during combustion, we can derive from the resistance offered to the passage of the current, a mathematical relation of the temperature to resistance, and from that we may calculate the calorific value Where this method is pursued it is satisfactory to the purchaser of coal to know what is the highest quantity of heat he can obtain from a given grade or quality of coal.

The Formation of Steam.

There is no mystery in the formation of steam. It is a physical process and is quite capable of being easily understood by those who are inclined to approach the subject from this standpoint. The chemical composition of water is H_2O; that is, it is composed of two atoms of hydrogen to one of oxygen. In this form it is a chemical union and therefore differs entirely from what we know are its component parts. This compound can exist in three states—ice, water and steam. The fact that it may be any one of the three, is very largely determined by the activity of its constituent atoms and molecules, and this activity we speak of, for convenience, as the presence or absence of heat.

Flame is caused by rapid combustion, which is the result of uniting carbon and hydrogen with oxygen. The atoms of these substances, though they may be separated by almost infinitely short distances, yet in the act of combustion clash together with such an exceedingly high velocity as to manifest the phenomenon we call heat. In fact, the noted physicist, the late John Tyndall, has told us that these forces, acting through such minute distances, yet develop so prodigious a velocity that the forces of nature, such as the attraction of gravity—a force capable of holding our earth and the other planets in their courses—are quite insignificant when compared with the forces developed in the rushing together of what seems to us to be a war of atoms, too feeble for more than passing notice. What seems to be, is not always what is.

There is a certain action, or more correctly stated, molecular and atomic motion in the particles of even still water. The motion is comparatively sluggish, but still it exists. There is much more atomic and molecular activity in flame, and a law of nature makes itself comprehensible when we apply a flame to the walls of a vessel containing water. A temperature of 2,000 degrees Fahr. causes the atoms concerned in combustion to be in very rapid motion, while those of the water are comparatively slow. The law of nature, which here comes in, is that when any fast moving body comes in contact with one of slower motion, the fast-motion body loses some of its activity, and the slow-moving body gains in speed. Thus the agitation is communicated to the water. Some heat is imparted to the walls of the containing vessel, but the bulk goes through and reaches the water, so that its activity is thereby much increased.

If the process of increasing the atomic or molecular activity of the water goes on, the water becomes hotter and hotter, until the critical temperature of 212 degrees Fahr. is reached. Here, if the vessel is open to the air, at a pressure close to 14.7 lbs. to the square inch, the temperature of the water goes no higher, and we say the water boils, and steam is formed. The atomic or molecular activity is now, in the open vessel, able to burst through the restraining pressure of the atmosphere, and the molecules of the water fly apart, beating back the surrounding hot water, rising quickly to the surface, on account of the lightness of the bubble of steam now formed, and the steam leaves the containing vessel at a temperature of 212 degrees Fahr.

The same phenomenon is capable of taking place when the vessel is not open to the air. The initial pressure may have been 14.7 lbs. (one atmosphere), but the accumulation of the steam above the boiling mass of water increases the pressure and compels the water to put forth more activity, or, in other words, to be hotter, in order to push back the wall of water about each bubble, and to break away from the now quiescent and strongly pressed upon surface of the very hot water.

Some Interesting Facts

There is often some confusion in the minds of many persons as to the exact difference between what temperature is, and what is heat. The confusion is of the same kind as experienced in thinking of strategy and tactics. The same may be said of the words sex and gender. Gender is simply a grammatical term to show the class a word belongs to. It has no reference to a person, and to say that a woman is of the feminine gender has no rational meaning at all.

Heat is a measurable quantity. It is, as a unit, the amount required to raise one pound (another unit) of pure distilled water, one degree on the Fahrenheit thermometer. This unit of heat is usually taken at or near the maximum density of water, which is when it is close to 39 degs. Fahr. This amount of heat is spoken of as a British Thermal Unit (usually written B. T. U.).

Temperature, on the other hand, is shown in merely the arbitrary division of the thermometer. The Fahrenheit scale has 212 degs. between zero and the boiling point. The freezing point of water is 32 degs. above the zero point. The centegrade thermometer has exactly 100 degs. between these points, and the Réaumur thermometer has only 80 divisions between these critical points. The reason that the British nation adopted the thermometer they did is not a thing of today. In early times when thermometers were practically unknown, salt thrown on ice was believed to produce the lowest temperature known, and this was at that time probably quite true. Subsequent and more careful scientific experiments revealed the fact that greater cold could be offered even by Nature. The Fahrenheit thermometer was, however, not given up for the Centegrade scale, because many calculations and records had been made on the basis of the Fahrenheit scale.

Heat, then, is a measurable quantity, while temperature gives one a means of judging of the activity, with reference to heat, which a solid body or a liquid or gas may manifest at any time it is under examination. A further example of what heat is may be found when we come to take up the subject of fuel as a steam generator. One pound of pure carbon gives off, when burned to CO_2, about 14,500 B. T. U., and requires about 12 lbs. of air for its combustion. One pound of pure hydrogen gives about 62,000 B. T. U. and requires 36 lbs. of air to burn it thoroughly. Solid fuels contain a good deal of incombustible matter, which not only do not increase the heat, but actually uses up heat in bringing it up to the temperature of the burning mass. These substances form the bulk of the ash which has to be removed from the ash pan of a locomotive at the end of a trip, and this matter in its unconsumed form represents so much loss in the amount of time and material.

Liquid fuels contain (nearly all of them do) pure compounds of carbon and hydrogen if actually there is no by-product; but some give off a pasty or sticky soot which is, in a way, analogous to the ash of solid fuels.

In speaking about boilers, the expression horse power is often used. Strictly speaking there is no such thing as boiler horse power. It may, however, be understood in two senses. First as an arbitrary unit expressing the rate of work done in a given time. The usual value of this term is the evaporation of 30 lbs. of water from a temperature of 100 degs. Fahr. to steam at 70 lbs. pressure above the atmosphere. The second sense in which horse power is spoken of in connection with boilers is an approximate measure of the size and rating of the boiler by which it may be described, advertised, bought or sold. There is no uniform or generally accepted standard in this case. It is purely arbitrary, and is often governed by local custom or by the opinion of the maker or owner.

Fuel Conservation.

Mr. Eugene McAuliffe, manager, Fuel Conservation Section of the United States Railroad Administration, has addressed a circular letter to all motive power officials concerned with locomotive maintenance, wherein he makes pertinent observations in regard to several points at which inspection has shown sources of fuel loss, and from his letter we extract the following: "The inspection of locomotive front-ends on certain roads shows that there is a marked variation in the size of exhaust nozzles. In many instances exhaust nozzles have been decreased in size because of the presence of air leaks in the front-end, which of course partially destroys the vacuum and necessitates excess draft. Such leaks can be readily found when the engines are under steam or when they are located near to an outside steam supply, by using the blower to create a draft and holding a lighted torch to all seams and joints. In superheater locomotives with outside steam pipes, leaks are frequently found under the covering of the steam pipe where it goes through the sheet. When so located, the leak does not show a burnt spot. Any front-end leakage obviously increases the amount of gas and air which must be moved by the exhaust jet, and consequently necessitates a reduction in the size in the nozzle tip. This of course increases the cylinder back pressure and entails fuel losses, and in addition frequently leads to partial engine failures and to an increased cost of front-end maintenance."

Increase in Accidents.

Particular attention is being called to the increase of the number of accidents among railway men, and the need of a constant call upon all employers to exercise a greater degree of caution and determination in avoiding risk. It has been pointed out that in normal times the labor turnover among motive power department employes is made up very largely of unskilled labor, but the present demand for skilled labor has resulted in the working forces being depleted in all branches of the motive power department. The prevention of injuries among such employes is largely dependent upon familiarity with the use of tools, handling material, the movement of cranes and other work incident to the construction and repair of locomotives and cars, and until the men become familiar with the layout of the shops and the work in which they and their fellow employes may be engaged, they are less likely to ward against the natural hazards of the business than they are after some experience has been acquired. In many shops the working forces have been largely changed in recent times, and, as in all other departments of railroad business, the necessity for employing new men has created additional difficulties from a safety standpoint.

Many shops are now employing women to fill the positions formerly occupied by men, but sufficient time has not elapsed since this departure was made to determine the relation the employment of female help bears to accident frequency. It is believed, however, that female workers, as a general rule, are not as liable to injury as men, but it will require some time to determine the exact facts in the matter.

Locomotive Feed Water Heaters.

The growing interest in the subject of locomotive feed water heaters has found a timely expression in the admirable paper submitted by J. Snowden Bell, which appears in a condensed form elsewhere in our pages. The painstaking research furnishes an idea of how the subject has engaged the minds of many eminent engineers, and it is gratifying to know that the large measure of success which has come has been wrought out in the atmosphere of American enterprise. The need of fuel saving appliances was never so great as at present, and any device that pays for itself in a short time should be unhesitatingly applied. Standardization of parts is not intended in any sense to hinder the adoption of new appliances and new methods that are certain of economic advantages. That this has been reached in the matter referred to is beyond controversy, and it is expected of those in authority to order the adoption of such appliances forthwith. Meanwhile we commend the perusal of Mr. Bell's valuable historical article reflecting as it does so much light on the subject as well as credit to himself.

Air Brake Department

Suggestions from the Air Brake Association—Bleeding Off Brakes—Questions and Answers

Mr. Eugene McAuliffe, manager, Division of Operation, Fuel Conservation Section, U. S. Railroad Administration, having accepted a proposition from the Air Brake Association to render active assistance to the Government's Division on Fuel Conservation, Mr. F. J. Barry, president of the association convened a special committee of supervising air brake men in Chicago, on August 1 from 24 of the largest railroads in the United States. The committee consisted of Messrs. L. P. Streeter, Chm'n, I. C. R. R.; L. S. Ayer, Sou. Pac. R. R.; L. H. Albers, N. Y. C. Lines; J. A. Burke, Santa Fe R. R.; M. S. Belk, Sou. Ry. Lines; T. L. Burton, N. Y. C. R. R.; R. C. Burns, Penn. R. R.; T. W. Dow, Erie R. R.; H. A. Clark, Soo Line; H. A. Glick, B. & A. R. R.; H. A. Flynn, D. & H. R. R.; E. Hartenstein, C. & A. R. R.; M. E. Hamilton, Frisco Lines; P. J. Langan, Lack. R. R.; C. M. Kidd, N. & W. R. R.; C. H. Rawlings, D. & R. G.; Mark Purcell, N. P. R. R.; H. S. Walton, B. & Albany; H. L. Sandhas, C. R. R. of N. J.; C. H. Weaver, N. Y. C. R. R.; G. Terwilliger, N Y., N. H. & H.; Geo. H. Wood, Santa Fe; Robert Wark, M. P. R. R.; H. F. Wood, B. & M. R. R.; W. W. White, Mich. Central R. R.; R. M. Long, P. & L. E.; F. M. Nellis, secretary.

This committee's deliberations resulted in the consensus of opinion that its greatest and most needful help in fuel saving could be rendered through a materially decreased leakage in brake pipes on freight trains, which according to careful expert estimate, is now the cause of a wastage of more than 6,000,000 tons of coal annually. This wastage can be materially cut down in the opinion of the Air Brake Association Committee quickly and with little additional cost, if the following recommendations be diligently and faithfully followed up by railroads and government authority alike.

(1) In switching cars in hump yard service, hand brakes must be known to be in operative condition before dropping over the hump. Each cut should be ridden home and not be allowed to hit cars on make-up track at a speed exceeding three miles per hour, as excessive shocks result in loosened brake pipe and cylinder connections with attendant leakage at joints. Same conditions apply to general yard switching, and similar care should be exercised.

(2) When hose are uncoupled, they must be separated by hand and not pulled apart. Pulling hose apart is not only the most prolific cause of brake pipe leakage, but the damage annually due to train parting, account of hose blowing off nipples, also bursting, due to fiber stress, results in damage running into thousands of dollars. Angle cocks first must be closed if brake pipe is charged.

(3) Ample time must be allowed to properly inspect the air brakes and place them in good working order before leaving terminals.

(4) Freight terminals where conditions and business handled justifies, should be provided with a yard testing plant, piped to reach all outbound trains. At all freight houses, loading sheds, team tracks and other places where cars in quantity are spotted for any purpose long enough to make repairs and test brakes, air should be provided to do such work.

(5) On shop and repair tracks provided with air, brakes should be cleaned and tested in accordance with M. C. B. rules and instructions. Weather permitting, hose and pipe connections shall be given soapsuds test. Hose showing porosity shall be removed and all leaks eliminated before car is returned to service.

(6) Freight trains on arrival at terminals where inspectors are stationed to make immediate brake inspection and repairs, shall have slack stretched and left with brakes fully applied.

(7) Brake pipe leakage on outbound freight trains shall not exceed eight pounds per minute, and preferably should not exceed five pounds per minute, following a fifteen pounds service reduction from standard brake pipe pressure, with brake valve in lap position.

(8) A suitable pipe wrench should be furnished each caboose to enable trainmen to remove and replace hose and to tighten up leaks developing en route. Instructions directing its use should be posted in each caboose.

(9) A rule should be put into effect that trainmen must apply an M. C. B. standard air brake defect card in cases where defects develop en route, or for brakes cut out by them, defect to be checked off on back of card.

(10) Air compressor strainers must be known to be free of foreign matter before each trip and removed for cleaning if necessary. Steam pipe to compressor to be lagged outside of cab or jacket.

(11) Special effort must be made to reduce the leakage of the various air-operated devices on locomotives.

(12) In mounting air hose, the coupling should be gauged with an M. C. B. standard gauge, and the coupling and coupling packing rings known to be standard in each and every case.

(13) Special attention should be given to maintaining brake pipe, brake cylinder, reservoir, retaining valves and pipe secure to car.

(14) The importance of competent air brake supervision to successfully cope with existing conditions cannot be overestimated.

(15) In the recommendations submitted it is not the intent in any way to abrogate existing instructions or rules that are now in force that are more stringent than those recommended, as these recommendations are intended to represent maximum conditions.

Bleeding Off Brakes.

In last month's issue we mentioned a failure of brakes to release with particular reference to the LN equipment. The failure of brakes to release with PM equipment was quite as prevalent at one time, but a car brake reservoir of PM equipment that has been overcharged can be released with one application of the brake, as it is possible to bring the auxiliary reservoir pressure down to the adjustment of the high speed reducing valve in one application, whereas with LN equipment several brake applications may be necessary as pointed out. As to bleeding off a brake or releasing it by means of the reservoir drain cocks, the manner in which the LN equipment is thus released has been explained, with PM equipment there is but one reservoir to bleed unless the car has a double brake equipment, and with the PC equipment, the service reservoir drain cock is opened to release a brake and with the UC equipment the auxiliary reservoir drain cock should be used for this purpose if it becomes necessary to do what is termed "bleed off" a brake.

In connection with the failure of brakes to release, and with the understanding that the brakes should be released from the locomotive, when one is attached to the train, a car with PC equipment must necessarily be released with the service reservoir drain cock when it is desired to release a brake by bleeding it, as the pressure chamber of the control valve has no drain or bleeder cock. Bleeding the service reservoir involves a considerable loss of air pressure as the service reservoir pressure must be practically exhausted in order to allow the brake cylinder pressure to flow back through the application portion of the control valve and permit the brake cylinder piston to recede. However, with

either the PC or UC equipment, an increase of 2 lbs. pressure in the brake pipe above that in the auxiliary reservoir or above the pressure in the pressure chamber of the control valve, will positively effect a release of brakes regardless of the pressure remaining in the emergency reservoirs. If either the PC or UC valves deteriorate to such an extent, from any cause whatever that the brake will not release upon a 2 lb. increase in brake pipe pressure above that in the auxiliary or pressure chamber, those valves should be removed and replaced by repaired and tested valves as it is no longer safe to attempt to operate them because if they are in any reasonable state of operative efficiency, they will positively bleed themselves off promptly upon an increase in brake pipe pressure above that in the auxiliary or in the pressure chamber, regardless as to the pressure that may remain bottled up in the emergency reservoirs.

Particular care should be exercised to prevent the possibility of overcharging the reservoirs on a train of cars, because if there is brake pipe leakage enough to cause an application of the brakes with the brake valve handle on lap position, an overcharge will result in brakes sticking when the handle is placed in running position, and if the brakes cannot then be applied with a full service brake application, without delaying or stalling the train, it will be necessary to carry the brake valve handle in full release position until such time as the pressure may be reduced by one or more applications. Placing the brake valve handle in release position adds the main reservoir volume to that of the brake pipe and the leakage that was previously sufficient to exceed the rate at which air pressure could flow back from the auxiliary reservoirs into the brake pipe and prevent an application of brakes, cannot reduce both volumes at the required rate to produce a movement of the car brake operating valves regardless as to the condition of the pump governor. Such possibilities point out the advantage of having a pump governor in a sensitive condition, and if necessary to carry a brake valve handle in release position, the governor may be relied upon to prevent a reduction in pressure that would result in an undesired application of the brakes on a train.

QUESTIONS AND ANSWERS

Locomotive Air Brake Inspection.

(*Continued from page 257, August, 1918.*)

447. Q.—What is the function of the air compressor?

A.—To compress air for the operation of the air brake, and sometimes for the operation of other devices on locomotives and cars.

448. Q.—What is the function of the main reservoir?

A.—To store a supply of compressed air for the operation of the brake system, to cool the temperature of the compressed air down to the temperature of the surrounding atmosphere, and to collect dirt and foreign matter that passes through the compressor.

449. Q.—What is main reservoir pressure used for?

A.—Principally to release brakes and recharge the brake system.

450. Q.—Why is it necessary to cool the compressed air in the main reservoir to the temperature of the surrounding atmosphere before it leaves the reservoirs?

A.—To allow the moisture to be deposited in the reservoirs.

451. Q.—Where does the moisture come from?

A.—It is always present in the atmosphere.

452. Q.—Why will there be no deposit of moisture in the main reservoir if the compressed air is not cooled at this point?

A.—Because the higher the temperature of the compressed air, the greater the capacity of compressed air per square inch, to hold moisture, and the moisture so held will be retained until the air is cooled.

453. Q.—Why is the moisture deposited where the compressed air is cooled?

A.—Because the lower the temperature of the compressed air, the less the capacity to hold moisture in suspension, and the pressure remaining constant while the temperature is lowering, the water is squeezed out of the compressed air.

454. Q.—What would be the effect of admitting a quantity of water to a main reservoir filled with compressed air under a high temperature?

A.—The water would be absorbed by the compressed air and carried to some other point in the brake system.

455. Q.—How is the temperature of the compressed air obtained?

A.—By compressing the air.

456. Q.—Please explain this further?

A.—Forcing the fine particles of air together produces friction and the friction in turn generates heat.

457. Q.—Technically, what is the work done by the compressor transformed into?

A.—Heat.

458. Q.—What becomes of the moisture or water, if the compressed air is not cooled in the main reservoir?

A.—It is deposited at the point of equilibrium between the surrounding atmosphere, and the compressed air.

459. Q.—In air brake operation, where is this point?

A.—In the brake pipe of a train of cars.

460. Q.—Is there any objection to this?

A.—In the winter time the water is likely to freeze and cause trouble, but in warm weather it is blown into the car brake operating valves where it causes the lubricant to be less effective or it results in certain brake actions that will be mentioned later.

461. Q.—What is the law that governs the capacity of the atmosphere or compressed air to hold moisture?

A.—It varies directly with the increase in temperature and inversely with a rise in pressure, the temperature remaining constant.

462. Q.—What do you understand by this?

A.—That after being cooled in the main reservoir and having the moisture deposited, the compressed air may be reheated by pipes running close to the boiler or through pipe friction, and again it may absorb moisture from the main reservoir and deposit it elsewhere.

463. Q.—What is relied upon to cool the compressed air in the main reservoir?

A.—Liberal lengths of circulating or main reservoir connecting pipes.

464. Q.—What should be the length of the air pump discharge pipe?

A.—It depends somewhat on climatic conditions, but usually there should be from 25 to 45 ft.

465. Q.—How much in the connecting pipes?

A.—About the same length.

466. Q.—What is the effect of too long an air pump discharge pipe?

A.—There is a liability in cold weather of freezing up at the connection to the first main reservoir.

467. Q.—What is the object of long slender main reservoirs of the tube type?

A.—To permit of a circulation of the compressed air through the reservoirs.

468. Q.—How should the pipe connections be made?

A.—The flow of air should be in at one end of the reservoir and out at the other.

469. Q.—How often should the main reservoirs be drained?

A.—Before each trip.

470. Q.—From where should the pipe connection to the brake valve be made?

A.—From the opposite end of the second or the last main reservoir from which the connecting pipe is attached.

471. Q.—What volume of compressed air space should the main reservoirs contain in passenger service?

A.—Not less than 50,000 cu. ins.

472. Q.—In freight service?

A.—Not less than 60,000 cu. ins.

473. Q.—What is the effect of too small a main reservoir volume?

A.—It tends to contain too small a volume for the release and prompt recharge of brakes on trains, and tends to cause overheating of the compressors.

474. Q.—What is the effect of an excessively large main reservoir volume?

A.—Under certain conditions it tends to cause a slow recharge of brakes in freight service.

475. Q.—Under what conditions?

A.—Where the main reservoir and brake pipe equalize at some point below the adjustment of the feed valve.

476. Q.—How does this lengthen the time required to recharge the brakes?

A.—The compressor must then charge both the large main reservoirs and the brake pipe at the same time.

477. Q.—If the main reservoir pressure is maintained at a figure somewhat near the maximum pressure will the large main reservoir volume recharge the train brake reservoirs at a faster rate than a smaller main reservoir volume?

A.—Yes.

487. Q.—How so?

A.—The larger volume will equalize with the brake pipe at a higher figure.

479. Q.—What is the law that applies to the compression and expansion of the atmosphere with regard to the space it occupies?

A.—Doubling the pressure halves the volume and doubling the volume halves the pressure.

480. Q.—Explain more fully?

A.—If a reservoir having one cubic foot of compressed air space contains 60 lbs. air pressure per square inch, compressing this volume to ½ cu. ft. space, it will result in 120 lbs. air pressure per square inch, or if the 1 cu. ft. of compressed air under 60 lbs. pressure is expanded into another vessel of the same cubic capacity, the pressure will equalize at 30 lbs. pressure per square inch. This is in accordance with Boyle's law.

481. Q.—What is the effect of heating compressed air besides increasing its capacity to hold moisture?

A.—It expands it. If the heat of compression remains in the air in the cylinder, it is called Isothermal compression. If the heat of compression is constantly abstracted, it is called Adiabatic compression.

(To be continued.)

Train Handling.

(Continued from page 259, August, 1918.)

469. Q.—How would the brake applications on a passenger train be governed if the inspectors were to announce that there was a car in the train without a high speed reducing valve or a safety valve in the brake cylinder?

A.—Care would be taken to make the total brake applications no heavier than absolutely necessary.

470. Q.—Why?

A.—To prevent a much higher braking force on this car if a heavy brake application was made.

471. Q.—What should be done if the brake was to suddenly be applied at the front of the train?

A.—The throttle would be immediately closed and the brake valve handle moved to emergency position.

472. Q.—For what purpose?

A.—To retain the pressure in the main reservoir and build up a high braking power on the locomotive.

473. Q.—How should the brake valve be handled on a freight train under this condition?

A.—The handle would be moved to lap position.

474. Q.—When picking up cars from a side track, what must be done before moving them out on the main track?

A.—A test of the brakes must be made.

475. Q.—What kind of a test?

A.—A terminal test, all of the brakes must be examined to know that they apply and release properly or that if any are inoperative, adding them to the rest of the train will not reduce the percentage of operative brakes below 85 per cent.

476. Q.—Can a car with an inoperative hand brake be placed as the rear car of a train?

A.—Under no circumstances.

477. Q.—When coupled to a train with two locomotives, which engine must handle the brakes?

A.—The leading engine.

478. Q.—What could be wrong if with two engines a brake application was made for a brake test and the brake pipe exhaust port of the brake valve would not close and the brakes failed to apply properly?

A.—It would indicate that the brake valve cut out cock on the second engine was open.

479. Q.—What would be wrong if the brake valve was placed in service position and the brake pipe exhaust port closed about as soon as the valve handle was returned to lap position?

A.—It would indicate a very short train pipe, or a closed angle cock near the head end of a long train.

480. Q.—What would be indicated if the brake pipe exhaust was very short but the brake applied heavily and the safety valve of the distributing valve opened?

A.—That the brakes on the train had operated in quick action.

481.. Q.—Which hand of the air gauges would indicate this?

A.—The black hand of the small air gauge.

482. Q.—How would it act?

A.—It would drop suddenly in accord with the drop in brake pipe pressure.

483. Q.—Why is the black hand of the small air gauge connected with the brake pipe below the double-heading cock?

A.—To indicate the pressure in the brake pipe when the engine is the second one in double heading.

484. Q.—In stopping a train on a grade should air brakes or hand brakes be used to hold the train if the engine cuts off?

A.—Hand brakes under all circumstances.

485. Q.—Why?

A.—The air brake system of a freight train invariably contains leaks that may result in a release of enough brakes to cause a runaway if the engine is detached or the air brake held applied for a considerable length of time.

486. Q.—What is the effect of excessive brake pipe leakage?

A.—Besides taking the control of the brakes out of the hands of the engineer, it contributes to brakes sticking, causes overheating of air compressors, and prevents the maintenance of standard brake pipe pressure.

487. Q.—What should be the maximum amount of brake pipe leakage per minute?

A.—It should not exceed 7 lbs. per minute.

488. Q.—How is the leakage noted?

A.—By making a 15 lb. brake pipe reduction for the brake test, and noting the fall of brake pipe for the next minute after the service exhaust port has closed.

489. Q.—Has the length of train, that is, the brake pipe volume, any bearing upon the amount of brake pipe leakage that should be permitted in pounds per minute?

A.—Yes, with one train of 50 cars and another of 100 the same amount of leakage per minute in both trains means that double the volume of air is escaping from the long train.

490. Q.—What does this mean with the long train?

A.—That the compressor must furnish a double amount of compressed air in order to supply brake pipe leakage.

491. Q.—What would 4 lbs. per minute leakage on the 100 car train equal in leakage from the 50 car train so far as the supply is concerned?

A.—It would equal a leakage of 8 lbs. per minute with the 50 car train.

492. Q.—Which train would naturally be the most difficult to handle, from a view point of control by the engineer?

A.—The 50 car train with the 8 lbs. leakage per minute.

493. Q.—Why?

A.—Because the additional brake pipe reduction after the brake valve handle was placed on lap position after an application would be twice as rapid with the 50 car train.

494. Q.—Can the train crew observe the amount of brake pipe leakage that exists at such times as when the brake valve handle is in lap position with the brakes applied or when the engine is cut off from the train?

A.—Yes, by the air gauge in the caboose.

495. Q.—Where are pressure valves used?

A.—Whenever descending a long heavy grade, or to assist in holding in the train slack at points where stops are likely to be made.

496. Q.—What is the effect of failure to return the valve handles to their ver-

tical position when reaching the foot of the grade, or when their use is no longer required?

A.—Brakes dragging and frequently damage to wheels.

497. Q.—What two kinds of slack are in a train of cars?

A.—Loose slack from lost motion in car couplings and spring slack.

498. Q.—When handling a train, do they work together or in opposition?

A.—They work together.

499. Q.—What is understood by the term loose slack?

A.—That which can be run in or out without compressing the draft gear springs.

500. Q.—What is the effect of a rapid change in this slack?

A.—Shocks to the train.

501. Q.—What is the effect of the spring slack?

A.—This additional amount helps to drive the slack in the opposite direction and increases shocks when the spring tension is releasing.

502. Q.—What is the effect of shutting off steam suddenly when engine is working hard and applying the brake heavily?

A.—A driving together of the train that sometimes results in "buckling" a wooden car and there is always the liability of driving in couplers.

503. Q.—What is frequently the effect of making light 3 or 4 lbs. brake pipe reductions for a stop?

A.—It results in undesired quick action of brakes if there are any triple valves in the train that might possibly work in undesired quick action.

504. Q.—What is another bad effect of very light brake pipe reductions?

A.—It tends to cause brakes to fail to apply throughout a train, due to a certain amount of auxiliary reservoir pressure that will flow back into the brake pipe through the triple valve feed grooves, and permit of leakage through the brake cylinder leakage grooves.

505. Q.—What is a loss of train control through this method termed?

A.—A loss through "dribbling on" the brakes.

506. Q.—What should be particularly observed in starting a freight train, from the viewpoint of acceleration?

A.—The engine should be kept at a slow and uniform speed for at least two car lengths.

507. Q.—Why?

A.—In order to get all of the cars of the train in motion before any material speed is attained by the locomotive.

(To be continued.)

Car Brake Inspection.

(Continued from page 259, August, 1918.)

447. Q.—And the expression V^2?

A.—The speed of the train or car in feet per second multiplied by itself, which is termed "squared."

448. Q.—What would this formula look like in figures if it was desired to calculate the stop distance of a car running at the rate of 60 miles per hour on a level track, and the average co-efficient of friction was 10 per cent. as previously mentioned and the brake rigging developing 85 per cent of the calculated cylinder pressure and if the percentage of emergency braking ratio was 150 per cent.?

$$\text{A.—SD} = \frac{88 \times 88}{2 \times 32.2 \times 1.5 \times .10 \times .85}$$

where SD is the stop distance.

449. Q.—How is the figure 88 obtained?

A.—The speed in feet per second at a 60 mile an hour rate.

450. Q.—How is this found?

A.—Multiplying the speed in miles per hour by 1.47.

451. Q.—How is the 1.47 obtained?

A.—By dividing the number of feet in a mile by the number of seconds in an hour ($5280 \div 3600$).

452. Q.—After the calculation is made, what allowance must be made for the distance the train will run from the time the brake starts to apply until it is fully effective?

A.—As at least two seconds time will elapse before full brake cylinder pressure will be obtained, it must be considered that from the time of brake application to the time full brake cylinder pressure is obtained the brake is applied on an average of one-half the full effectiveness for the entire time (average Zero to Maximum) or in full one-half of the time in effect, and therefore it must be considered that the train will be running without a brake for the first second and with the brake fully applied during the second second of time.

453. Q.—In making the above calculation what will be the distance indicated?

A.—944 ft. from the point the brake is fully applied, or 1,032 ft from the point at which the brake is applied.

454. Q.—Can a train stop be made with modern cars in such distances?

A.—Yes, with modern types of clasp foundation brake gear and the electro-pneumatic brake.

455. Q.—Have you any idea as to why so many questions are asked concerning the forces in effect on a revolving car wheel when a brake shoe is pressed against it?

A.—Because if anyone is desirous of possessing a good general knowledge of air brake operation it is necessary to have an understanding of the fundamental principles as well as to be able to trace the flow of air through ports and passages.

456. Q.—Can you explain in a very few words how an automatic air brake on a car operates?

A.—Compressed air enters a brake pipe extending through the entire length of the car from which the triple valve traps an equal pressure in a reservoir so that the compressed air cannot be withdrawn from the pipe without the reservoir pressure moving the triple valve in a manner to admit pressure to the brake cylinder and apply the brake.

457. Q.—Could an automatic brake be made without a triple valve?

A.—Yes, to illustrate the principle of the operation, the brake pipe connection could be made to the non-pressure head of the brake cylinder and the brake piston supplied with a stuffing box, nut and gland and the auxiliary reservoir could be connected to the pressure end of the brake cylinder, which would serve as an automatic brake.

458. Q.—What would then occur when air was admitted to the brake pipe?

A.—The brake piston would be pushed to release position and the reservoir would charge through the leakage groove of the brake cylinder.

459. Q.—What would occur if the brake pipe pressure was withdrawn at a faster rate than that at which it could flow back through the leakage groove?

A.—The higher pressure in the reservoir and on the pressure end of the brake piston would force the brake piston out and apply the brake.

460. Q.—Why was not this discovered before the triple valve was invented?

A.—It is quite likely that it was, but such a brake is impractical especially under modern operating conditions.

461. Q.—What is the most prolific cause of disorders in a triple valve.

A.—Dirt and foreign matter being collected by the lubricant that is used on the movable parts of the triple valve.

462. Q.—What kind of lubricant should be used in a triple valve?

A.—None whatever, but if the rules of the company specify lubrication only dry graphite should be used.

463. Q.—Why is oil frequently used in triple valves?

A.—Because the use of oil has always been associated with the operation of machinery.

464. Q.—What bad effect has the use of oil?

A.—It is the source of practically all of the air brake trouble encountered in car brake operation.

465. Q.—How often should a triple valve be cleaned?

A.—As often as necessary.

466. Q.—When is it necessary?

A.—Whenever the moist lubricant picks up enough foreign matter to interfere with the proper operation of the valve, or whenever the rules of the company or the federal regulations demand cleaning.

467. Q.—How often might it be necessary to clean a triple valve on a car, if the repair work and lubricating was properly done, and if the locomotive and

yard plant equipments were properly installed and maintained, and if there was no specified time of cleaning?

A.—Possible every 2 or 3 years.

468. Q.—How often should a triple valve be tested?

A.—Whenever the car is made up in a train or about once every week.

469. Q.—What is the difference between a brake test and a triple valve test?

A.—The brake test is made with the locomotive coupled to the train, while a triple valve is tested with a portable brake test truck or some device that will constitute a test of the operation of the triple valve under severe conditions.

470. Q.—Why does the locomotive attached to a train fail to constitute a severe test of brakes?

A.—Because it is made under the most favorable circumstances with full main reservoir pressure and a heavy brake pipe reduction.

471. Q.—Does the brake test then give any assurance that the triple valve will operate correctly after the train is on the road?

A.—None whatever, as the application though possibly a much lighter brake pipe reduction followed by an attempt to release with a depleted main reservoir pressure establishes an entirely different condition from that encountered during a brake test at a station.

472. Q.—Is there any other difference?

A.—Quite a bit as to differences in rate of brake pipe leakage, the leakage invariably increases as the train is stretched and being hauled along the road.

473. Q.—How would a triple valve be tested on a car if a portable brake test truck cannot be obtained?

A.—With some device whereby the increase in brake pipe pressure during a release can be regulated to a predetermined figure.

474. Q.—How many triple valves may be tested at one time in this manner?

A.—But one at a time can be accurately tested.

475. Q.—Why not more?

A.—Because if the rate of increase in the brake pipe is based on the brake pipe volume of the car alone and made through a fixed opening, the first triple valve that moves to release position adds the auxiliary reservoir volume to that of the brake pipe and the brake pipe volume is immediately multiplied several times so that the next triple valve will not be tested under the same release condition as the first.

476. Q.—How is a release test made in this manner with type L triple valves?

A.—The supplementary reservoirs are usually cut out so that the brake will not graduate with the slow increase in brake pipe pressure and make it appear that the triple valve had failed to move to release position.

(To be continued.)

Pulverized Fuel in Stationary Boilers

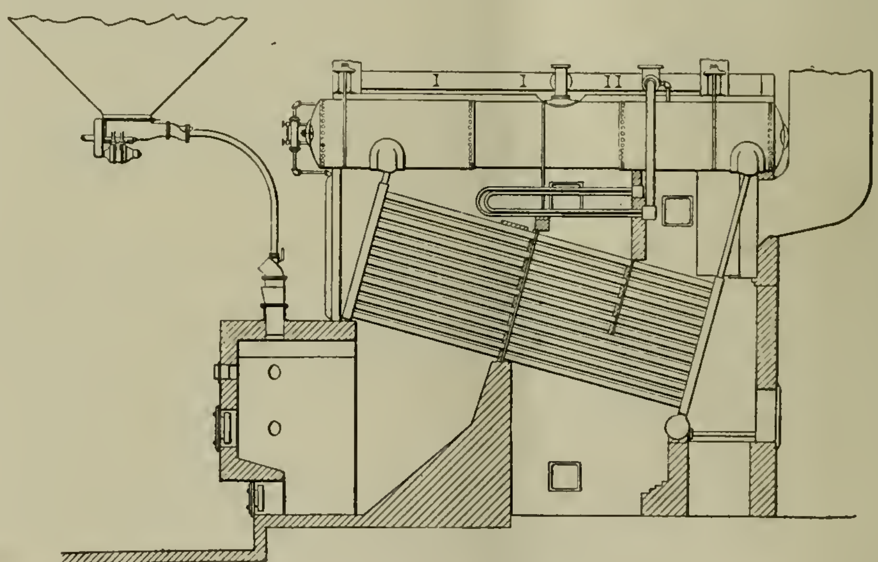
It should be a matter of congratulation to all who are interested in the use of stationary boilers to learn that after four years development work and progressive elimination of the difficulties encountered, the Locomotive Pulverized Fuel Company is now prepared to build and deliver for operation, complete installations of pulverizing plants, together with equipment for the economic use of the product under boilers. The equipment can be installed without the necessity of resetting of boilers, or making radical changes.

The degree of economy secured is readily understood when it is remembered that efficient combustion is obtained only when each combustible atom is brought into contact with the necessary atoms of oxygen in an atmosphere being acted upon by sufficient heat to make possible the progressive chemical union of the elements of combustion. The ultimate results can only be obtained with an ash-free combustible in an atmosphere of pure oxygen. The insurmountable difficulties in obtaining ideal combustion requirements are the non-combustibles in the coal and the inert nitrogen in the atmosphere, and, as is well known, pulverizing the fuel has long been recognized and accepted in theory as the one way in which these ideal conditions could be most closely approximated.

It may be stated that the organization of the Locomotive Pulverized Fuel Company was specifically created to bring the use of pulverized fuel to a commercial standpoint by overcoming in practice the elements which were responsible for previous failures. It may also be justly added that a great deal of intelligent pioneer work in attempting to overcome the inherent difficulties in burning pulverized fuel in suspension had been done in the past.

All these difficulties have been completely overcome, with the result that the wide-awake company has made available to the users of fuel, a simple, automatic and dependable means for utilizing by the most efficient method any available solid fuel, and obtaining the ultimate thermal results independent of the amount or character of the ash contents or the volatile constituents of solid fuel without the need of constant attention by the boiler-room operators, and without the necessity for operating interruption due to slag, or, as we have already stated, to excessive brick renewals.

Our illustration shows a typical application of what is known as the "Lopulco" system, but the company's service department composed of fuel and combustion engineers is ready to advise all interested in the adoption or use of pulverized fuel to the end that the best and most economical method of adapting or installing the necessary appliances may be secured.



TYPICAL "LOPULCO" APPLICATION.

Among the most recent comparative reports showing detailed data of tests the following are the economic results:

Total cost of pulverized fuel delivered to boiler. (Not including fire-room labor).....	$69.94
Total cost of coal burned on grates or in retorts to produce same amount of steam. (Not including fire-room labor)....	$77.40
Net fuel saving for 12-hour run. (Not including fire-room labor)	$7.46
Net saving per boiler h. p. Year of 6,000 hours for fuel and labor. (Not including fire-room labor)	$6.96
In a 3,000 h. p. plant this shows an annual net operating saving in fuel and labor (not including fire-room labor) of.......	$20,880.00

The Landis Stay-Bolt Machine.

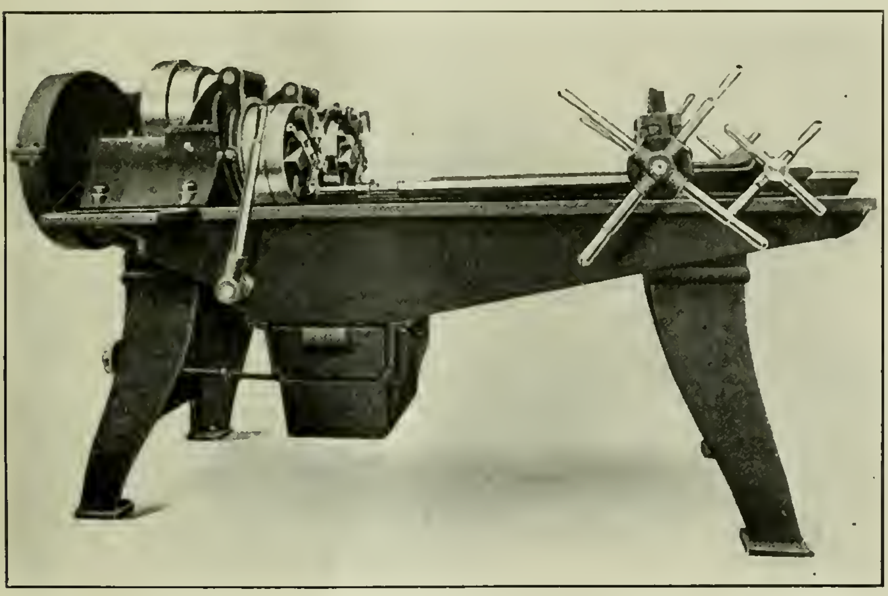
The superiority of the Landis chaser is so well known to all interested in the threading of bolts that it is a mere repetition of an old story to state that the chasers have a much longer life than those of any other type of die. Their application, however, to the growing requirements of varied services brings something new into prominence and popular favor. The demand, chiefly on the part of the manufacturer and users of stay bolts, for a threading machine of more than ordinary carriage, has resulted in the recent production of the Landis Stay-Bolt machine. It has already come into much favor, possessing, as it does, in an eminent degree, the elements or reliability and durability. This machine is furnished in both single and double models.

As the diameter of most stay bolts come within the range of 1½ in. die head, the type of machine is limited to one size. The pitch of stay-bolts is also usually constant for all diameters, and since the pitch angle of the Landis die is controlled by the inclination of the chaser in its holder, special stay-bolt chaser holders are reqquired. One set of stay-bolt chaser holders covers a range from 15/16 in. to 1 1/16 in., inclusive. When used without a lead screw attachment, and a range from ⅞ in. to 1⅛ in., inclusive, when used in conjunction with a lead screw attachment. These holders, it will be observed, when used without a lead screw attachment are milled to have a diametrical range of ⅛ in., and when used in conjunction with a head screw attachment they have a diametrical range of ¼ in.

The rack also shows a marked improvement in being constructed with openings between the teeth, preventing the accumulation of chips which would tend to jam the pinion and interfere with the movement of the carriage. The rack is supported at both ends, and has a well elevated central location between the carriage ways. The bed has also a new feature in having a gradual slope from both ends toward the reservoir to insure a complete drainage for the cutting lubricant. The bed is cast in one piece, and a detachable pan is furnished for the chips.

The head, which locks within itself, produces the effect of a solid die, thereby relieving the yoke of all cutting strain. It is opened and closed automatically by the forward and backward movements of the carriage, and is controlled by means of a trip rod by which an adjustment for any desired length of thread may be obtained. The head is also fitted with a lever whereby it may be opened and closed by hand in case of emergency. The cone pulley is mounted on top of the machine, to economize floor space and belting, the driving gears being enclosed. The head is made entirely of steel and the high-speed steel used in the die cone can be used to a better advantage than in any other form of die. The material used in the entire machine is of the best and in every detail the fitting may be said to be the acme of perfection because there has come to the firm many clever engineers whose experience has added much to those who have gone before, and the combination gives promise to a higher degree of perfection in the future.

The general dimensions embrace a travel of carriage of 36 in., floor space 7 ft. 3 in. by 3 ft. 6½ in., diameter of tight and loose pulleys 9¾ ins. for 3 ins. belt, number of speeds 3, speed of countershaft, with carbon steel chasers, 225 revolutions per minute; with high-speed chasers, 360 revolutions per minute. Net weight 2,650 lbs., gross weight, 3,300 lbs.



LANDIS STAY-BOLT THREADING MACHINE.

Combustion.

A ton of average bituminous coal contains about 1,600 pounds of oxygen, nitrogen, sulphur and ashes. But if this coal be coked, the 600 pounds of hydrogen driven off by the heat will carry about 300 pounds of carbon in combining with it, making 400 pounds, or nearly 10,000 cubic feet, of carburetted hydrogen gas. Thus for every 2,000 pounds of coal we have about 1,300 pounds of solid carbon or 400 pounds of carburetted hydrogen to be burned, the remaining 300 pounds being waste. When such coal is subjected to a temperature of about 1,200 degrees, carburetted hydrogen will be generated and expelled from the coal, so that if a shovelful of the latter is thrown into the firebox of a locomotive with a bright fire evenly spread over the grate and a few inches thick, the carburetted hydrogen will unite with the air which passes through the fire and will be burned without smoke. If, however, a dozen or more shovelfuls are thrown in at once, a common practice with poor firemen, the temperature of the firebox will be so much reduced that clouds of smoke will be formed. Now, why is this true?

As stated already, if a shovelful of bituminous coal is thrown on a bright fire, as soon as it is sufficiently heated, carburetted hydrogen will be generated. If there is enough air above the fire, within reach of the escaping gas from the coal, the gas will be burned provided the temperature is high enough to keep it lighted. But inasmuch as the oxygen of the air has more affinity for the hydrogen of the gas than for carbon, if there is not enough oxygen to combine with both, it will by preference unite with the hydrogen instead of the carbon of the gas. It so happens that carbon will not remain in the gaseous form except at enormously high temperature uncombined with some other element. Therefore, if there is not enough oxygen for the hydrogen of the gas, the carbon will remain free and will assume a solid form which is really smoke. If, on the other hand, there is enough air above the fire for both the hydrogen or carbon of the gas generated from the fresh coal, it will be generated without smoke provided the fire is hot enough to keep the gas burning.

Safety, effort and loyalty to your government go hand in hand. It involves the safety of us all, the safety of our country—world safety.

Are you "doing your bit" in saving food for our allies and our soldiers and sailors. It should be borne in mind that the battle does not depend upon those who are face to face with the foe, but upon those who are sustaining the brave men who are offering their lives for us that we may enjoy the right to live.

Electrical Department

Torque of Electric Motors as Applied to Electric Locomotives

Last month we began the discussion of the electrical term "Torque." To better understand how the torque is related to the tractive effort, we made a comparison between the steam and the electric locomotive. We showed that whereas in the case of the steam locomotive, the power and tractive effort can be easily calculated, as all factors are concrete and mechanical. In the electric locomotive it is not so easy to calculate. The power of the electric locomotive is expressed in terms of tractive effort, but the only fixed concrete part entering into the calculation is the wheel diameter. The force from the motors, or the torque, is not dependent upon quantities, such as the boiler pressure, diameter of cylinder and length of stroke, but upon the electrical design. It is dependent upon the number of armature coils and the number of turns per coil; upon the number of turns of the field coils, and the strength of the magnetic poles or fields. The number of armature coils and turns as well as the field turns are constant, but the magnetism varies with the amount of current taken by the motor so that the torque also varies with the current. The amount of current to the motor is at the control of the motorman, so that within safety limits as large a torque as desired can be obtained from the motors and the maximum power is not fixed as in an engine supplied with constant steam pressure. There is a certain relation between the current and the torque, but for practical purposes there is no formula to say what this torque is.

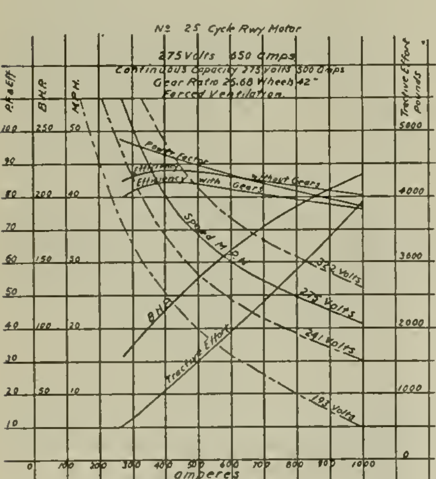


FIG. 1.—CHARACTERISTIC CURVES FOR A DIRECT CURRENT LOCOMOTIVE.

In order that the tractive effort of an electric locomotive can be calculated, a set of characteristic curves of the motor used on the locomotive is drawn up from test. These curves can be used to determine the locomotive performance. The curves show the relation between the current, the torque and the revolutions and it is possible, knowing one, to obtain values for the others.

It is the general practice to draw up

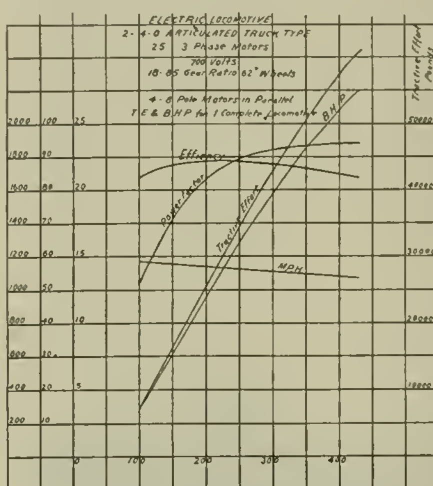


FIG. 2.—CHARACTERISTIC CURVES FOR A 3-PHASE LOCOMOTIVE WITH MOTORS CONNECTED FOR SLOW SPEED.

these curves for the complete locomotive, showing the total pounds tractive effort; the revolutions changed to miles per hour and the current to terms of current per locomotive. We are going to show various sets of these characteristic curves, tell how to read them and how to apply them to a locomotive.

All of the characteristic curves are laid out on the same basis so that one particular set can be referred to and the remarks in general will apply to all. We have taken the set shown in Fig. 1 for explanation, which are the characteristic curves for a direct current locomotive to operate on 2,400 volts. It will be noted that all of the curves, namely efficiency, miles per hour, brake horsepower, tractive effort are all plotted as ordinates with the current as a base. This arrangement is especially convenient, for by it the speed, tractive effort, etc., can be easily determined for any change of load.

When referring to a set of these curves, the various scales used should be carefully studied. To show how a set of curves is used, we shall assume that the locomotive under consideration (Fig. 1) is used for freight service, that it is equipped with four motors geared to 62-in. drivers and is hauling a load up a grade at the rate of 11.5 miles an hour. We should like to know: First, How much current is taken from the overhead trolley wire? Second, How many pounds tractive effort is the locomotive exerting? Third, At what efficiency is it operating? Fourth, What brake horsepower is being exerted? And fifth, How long could the locomotive run under these conditions without the electrical windings exceeding a rise of 60 degs. Cent. above the surrounding air when starting at an initial temperature of 25 degs. Cent. If the locomotive had already reached a constant temperature rise of 60 degs. Cent. how long could this work be handled before an additional rise of 20 degs. Cent. would be exceeded? Referring to the characteristic curve, Fig. 1, the information is obtained as follows:

One. Starting at point A, corresponding to 11½ miles an hour, follow along the horizontal dotted line until it cuts the M. P. H. curve at point B. This point B is the 11½-mile point on the speed curve. Now drop down vertically to the ampere scale, point C, which corresponds to 780 amperes taken by the locomotive from the 2,400-volt supply.

Two. The pounds tractive effort corresponding to the current taken is found by projecting the point D (where the vertical line BC cuts the Tractive Effort curve) horizontally to the point E on the Tractive Effort scale, which corresponds to 72,000 lbs.

Three. The efficiency at this load is found by extending the line BC until it

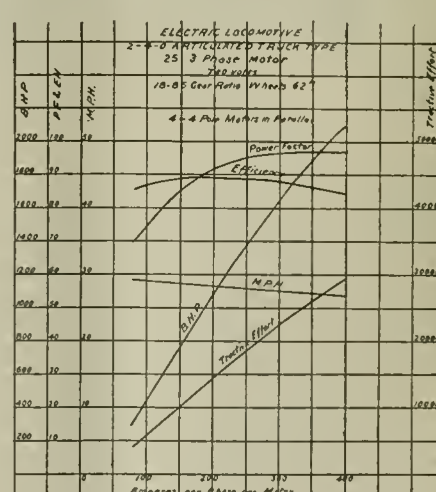


FIG. 3.—CHARACTERISTIC CURVES FOR A 3-PHASE LOCOMOTIVE WITH MOTORS CONNECTED FOR HIGH SPEED.

cuts the efficiency curve at point G, then horizontally to the efficiency scale point H, corresponding to an efficiency of 88.8 per cent.

Four. The brake horsepower is obtained by projecting horizontally to the B.H.P. scale, the point F where the vertical line BC extended, cuts the B.H.P. curve at point J, corresponding to 2,240 horsepower.

Five. The time the motor will stand this load and not exceed a temperature rise of 60 degs Cent. is obtained by projecting the point K, where the line BC cuts the temperature curve, horizontally to the time scale point M, which corresponds to 25 minutes.

Sixth. The time this work could be handled after the temperature of the motors had already reached a 60 deg. Cent. rise, and not exceed an additional 20 degs. Cent. rise, is determined by projecting point P to the time scale to point R, which corresponds to 4 minutes, stated previously.

As all of the curves are drawn with current as a base. Moreover, a line drawn vertically from any current will cut all of the curves making up the set, which means that the characteristics of the locomotive for a particular current are fixed and can only change with change in current value.

To better illustrate this, let us take another example. We might desire to know how much tractive effort the locomotive is capable of exerting when running at 20 miles an hour. Referring to Fig. 1 find 20 miles an hour on the scale, project over to the m.p.h. curve and down to the current, corresponding to 255 amperes. This vertical line cuts the T.E. curve at a point, if projected to the right, over to the T.E. scale, which will give 14,000 lbs. T.E.

Again we will assume that the locomotive is handling a load requiring 40,000 lbs. T.E. What speed will the train be running at? First find the 40,000 lbs. on the T.E. scale, project over horizontally to the T.E. curve, then vertically to the m.p.h. curve, then to the m.p.h. scale and we find the locomotive will be running at 13½ miles an hour.

Figs. 2 and 3 show the characteristic curve of a three phase or split phase locomotive. By the expression "split phase" we mean a locomotive similar to the one operating on the Norfolk & Western Railroad. Current is taken from only one overhead wire and thus is single phase current, but it is changed to three phase on the locomotive itself so that three phase motors are used, giving the constant speed characteristic. Two curves are shown as the motors are generally so designed that the number of poles can be changed (at the will of the motorman). That is, the motors may be operating as 4-pole machines or as 8-pole machines. The revolutions of the armature, hence the speed of the locomotive is twice as great with the 4-pole combination as with the 8-pole combination. The locomotive has therefore two constant speeds, one of approximately 14 m.p.h., the other of approximately 28 m.p.h. The various curves bear the same relation, so that the problems above set forth can be applied to these curves.

Another type of electric locomotive which should be mentioned, since it is

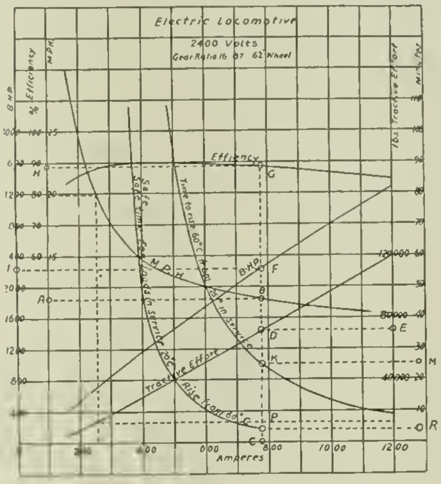


FIG. 4.—SINGLE-PHASE SERIES-MOTOR.

used in large numbers on the N. Y. N. H. & H. R. R., is the single phase locomotive. Instead of showing the complete curve for a single phase locomotive, we give in Fig. 4 the curves for one motor only, but the revolutions and the torque change over to m. p. h. and T. E. To obtain the entire locomotive performance it is only necessary to know the number of motors and multiply the current, T. E., brake horse power by the number of motors. The m. p. h. curve will not change, as all the motors are usually geared alike.

It will be noted that there are several different speed curves labelled with different voltages. Generally if not always with a single phase locomotive there are several transformer taps used, and the motorman can get increased speed by going from one tap to the other. Every tap is a running position so that it is customary to show the speeds at the different voltages, so that the performance of the locomotive can be determined for any speed.

The single-phase series motor is of the straight series type and is essentially a direct-current series motor, except it has resistance leads inserted in the armature windings.

Locomotive Parasites.

This somewhat ambiguous expression has been applied to the various steam-driven appliances on the train. The locomotive is the reservoir from which all the appliances derive their driving power. The air brake comes first as an auxiliary which uses up locomotive steam. Steam bell-ringers are equivalent to a small though steady leak. The electric headlight dynamo takes a comparatively large amount of steam to drive it; the blower also consumes steam, and the various leaks from boiler and engines form a constant drain on the supply. The simmering and blowing of the pops constitute a loss pure and simple. The injectors use live steam, and on passenger trains in winter the steam-heating apparatus makes a substantial draught on the generative ability of the boiler. On many trains there is an additional draught on the air pump for air to raise the water for washing, in the Pullman cars.

When the total for each one of these things is added together, it is not surprising to learn that about 15 per cent of the steam that goes to the cylinders is thus used. This 15 per cent. is reckoned for freight trains; but even with a lighter consumption of air on passenger trains for brakes than on freight, the parasites use up in various ways perhaps as much as 20 per cent. of that for which the steam was primarily generated. Whether these figures, which are given by a contemporary, are exact or not, does not matter here; they are probably approximately correct, but the fact that has been brought out is that the combined working of these appliances constitute a heavy drain on the resources of the boiler, and this means an increased consumption of coal.

It is not that we would advise the discontinuance of the "parasites." They are useful, each in its own way, and the employment of them adds much to the comfort of travelers and employees. Anyone of the appliances may not make or mar the work of the locomotive, taken on the whole. It is in the aggregate that their use of steam makes a definite appearance. From this it is evident that it is a mistaken policy to consider them, reverse gear, fire door openers and all the rest, as negligible quantities, which may run without attention between shoppings. Each one of the "parasites" uses up steam; any one of them may get out of order at any time, and the only solution of the problem, and one of the important steps in coal saving, is to give these appliances constant attention and to anticipate their failure by steady watchfulness and prompt attention.

Progress

The whole history of mechanical engineering in America is founded on the principle that whatever has been done is not the best that could be done. Each successive machine was regarded for years and years as but an experiment which led up to the better machine that followed it. It is only of late, when manufacturing has tended to take the place of engineering, and when progress is measured by numbers rather than by excellence, that an attempt at standardization has gained power, but cannot in any way stop inevitable progress in improvement.

A New Steam End Valve

Everyone who has worked on a railway—not just looked at it through the windows of a waiting room, or pounded a typewriter in a railroad office—knows the trouble which is usually experienced by a worker with steam heating hose, at the back of the train, giving out. The end valve is often just "cracked" to prevent the water of condensation from forming in the pipes and hose of the forward part of the train and to maintaining a constant flow-back. When it forms and is deposited, freezing and clogging of pipes and hose usually takes place. This is a serious matter for the worker.

The "cracking" of the valve at the end of the train relieves this trouble to a large extent, but it introduces another which cannot be ignored, because the end hose below the "cracked" valve receives the slow and steady drip of the water of condensation, and this has a tendency to rot out the hose, if it does nothing worse.

GOLD HEATING AND LIGHTING END VALVE.

In any case the life of the hose is prematurely shortened, contrary to the theory of conservation of railway material prevalent today. Here is the problem. It is to make the cure not only, not as bad as the disease, it is to eliminate the disease altogether and not merely to administer palliatives.

Mr. Edward A. Gold, president of the Gold Car Heating and Lighting Company, 17 Battery Place, New York, claims to have solved the problem in an efficient and satisfactory way. The valve he has designed is known by the number 1126 end valve. With this valve the drip from the water of condensation falls from the body of the valve and does not go into or on the rear hose.

The valve body is made of iron and the valve is practically a brass piston, double seated, and is moved by turning a spindle carrying a cam. This cam moves the valve forward or back, horizontally and at right angles to the line of piping or hose. The valve has two extension rods or spindles which move easily and closely in recesses in the thick walls of the valve. When the valve is shut the rear one is partly withdrawn from its guide socket, and on this rear expansion spindle a groove has been milled so that water or even steam can find its way out through the groove and into a small vertical chamber in which the set-screw (adjusted by a screw driver) has been placed, as a partial obstruction. From this vertical chamber the water of condensation passes out and falls to the ground.

The seats of this valve can be easily renewed without disconnecting any piping. The valve is substantially built, the body is made of iron and the cam and spindle are cast in one solid piece.

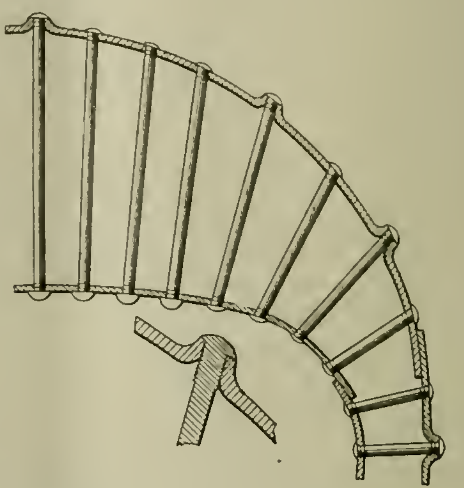
The Gold Car Heating and Lighting Company have prepared a very illuminating circular on this subject which they will be happy to send to anyone who writes to them for one.

Stay-Bolt Connection

Regarding the various forms of staybolts an interesting device has been patented last month by Peter F. Gallagher of Baltimore, Md., and assigned to the Flannery Bolt Company of Pittsburgh, Pa. The device, as shown in the accompanying illustrations, consists of an improved mode of connecting flexible staybolts with the outside sheets or shell plates of steam boilers, the object being to provide a connection which shall be proof against leakage or breakage of the parts at the point of connection, which avoids the use of parts auxiliary to the bolt and sheet, and which allows the bolt to have ample flexibility to compensate for expansion and contraction.

Fig. 1 is a vertical section taken through one side of a fire box and showing the application of the device. Fig. 2 is a sectional view through the inside sheet, and showing the connection of one of the stay-bolts therewith. It will thus be seen the tubular projection in the sheet forms an enlarged, inwardly flaring space between the bolt and the walls of the opening. The outer extremities of the tubular projections are plane surfaced to provide seats against which bear heads are formed upon the outer ends of the bolts. The flaring portion may also provide for the reception, plastic or of other yielding packing if desired, and permits relative motion between the bolt and shell or plate, in which motion of the tubular projection is permitted to partake by means of a certain degrees of resiliency inherent therein. It will also be understood that the tubular projections are punched and the circular walls thereof internally threaded, the extremity of the bolt when screwed in place projecting to the required distance beyond the seat, and when riveted in place provides a combined retaining and closure member which supplements the action of the threads to hold the belt for displacement, and at the same time co-operates with the threads to prevent leakage.

By these means it is claimed that there is sufficient resiliency in the parts to have relative movement without undue strain upon the tubular projection, thus avoiding the use of any auxiliary part whatever. The bolts are connected with the inner or fire box sheet in the usual man-



IMPROVED STAY-BOLT CONNECTION.

ner in general use or in any other preferred manner. The outer ends of all of the stay-bolts, or any desired number of them may be engaged with the tubular projections referred to whereby the bolts are fastened to the outer sheet.

Mr. McAdoo Is Right

Mr. McAdoo, Director General of Railroads, states that a great responsibility and duty rest upon the railroad employees of the United States. Upon their loyalty, efficiency and patriotism depends in large part America's success and the overthrow of the Kaiser and all that he represents. Let us not fail to measure up to our duty, and to the just demand of the public that railroad service shall not only be efficient, but that it shall always be courteously administered.

Safety Inspectors Wanted

On October 2 and 3 a civil service examination for inspector of safety appliances will be held. Applications should be made to the Civil Service Commission, Washington, D. C. Applicants must be between 25 and 50 years of age, and must have had considerable experience in railroad work. It is decided that a large number of appointments will be made, and the positions will in all likelihood be permanent.

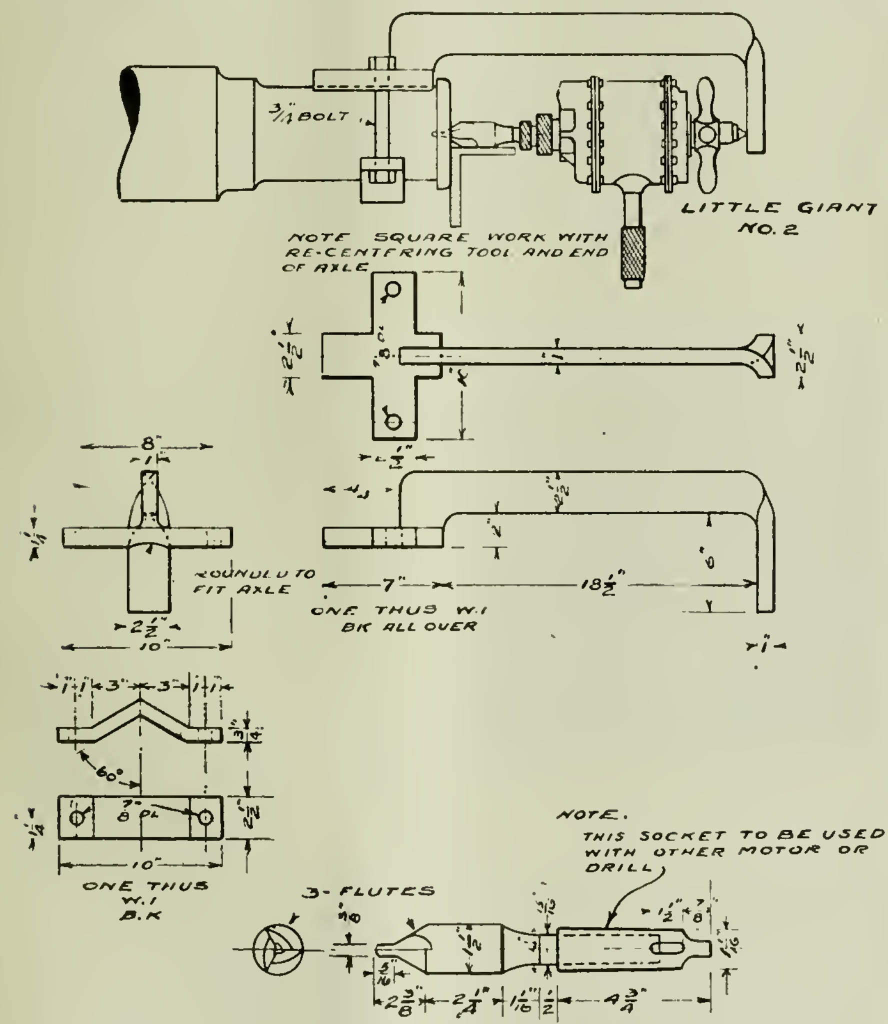
Device for Re-Centering Car Axles

BY A. C. CLARKE, PITTSBURGH, PA.

The accompanying drawing shows the details of a useful device for centering axles. At the bottom of the drawing the cutting tool is shown which drills the center cut deeper and also countersinks it, the other end of the tool, of course, being adapted to fit in the motor. The end of the clamp which fits, or, rather, is clamped on the journal, should be slightly rounded on the side that is next to the axle, the other clamp is plainly shown and no further description is necessary. This clamp is securely bolted to the axle with ¾ in. bolts as shown.

The proper location of the feed screw on the end of the compressed air motor is determined by squaring the tool and end of the axle as illustrated, and then the hole will be drilled and countersunk true. It will be readily seen how much easier it is to recenter an axle by this method than it is to lift the axle up on a horizontal boring mill or drill press, and after one end is done, lift and turn the axle in order to finish the other end, and possibly more than half of them have to be recentered before putting them in a lathe.

It may be stated that we have several of these in use at various points, and they are doing very satisfactory work, and it can be easily seen how useful and practical it is for the purpose indicated.



DETAILS OF DEVICE FOR RE-CENTERING CAR AXLES.

Railroading at the Battle Front.

Back of the entire allied battle line, there is a zone from four to five miles wide within which a perfect network of light railways, running over two-foot tracks, performs almost the whole function of transport. Grownup trains bring their freight—food, equipment, munitions, and even men—to the "rail heads," just out of ordinary cannon range. There the toy trains pick it up and distribute it practically into the trenches themselves, jolting along with charming sangfroid whether Fritz's shells be breaking in twos and threes or by the whole sky full.

America is not a pioneer in military light railroading. Our system is borrowed pretty liberally from French and British uses as we found them when we entered the war. Here and there, it is true, we have incorporated well-tested ideas developed in our own railroad or engineering experience, and as time passes we expect to embody other improvements. But we are using the French 60-centimeter tracks and in the main we have indulged in no "new-fangled notions."

Our light engines though are distinctly American—American built and brimming with what one might almost call American personality. They are of three sizes and two types—the gasoline engine which coughs over the tracks in daylight when coal-smoke would attract attention from the enemy, and the heavier steam locomotive which sleeps until sundown and shunts its trains around at night. But even this monster has a weight of only 23,100 pounds on its driving wheels, while some of the big locomotives on our home tracks weigh 10 times as much.

The "gas" engines are really only big motors geared to a locomotive drive. The 30-horsepower size weighs just 4 tons and the 50-horsepower but 14,000 pounds. They have a queer, squashed-together look, rather suggestive of the old Philadelphia "stoops" that descend invariably in three steps, but their pilots say they are "some jack rabbits." Even the more dignified steam locomotive, smartly enough turned out, has a certain lean and hungry air, a faint flavor of the original Stevenson Rocket model. However, it has more pull than anything else in the Army.

Mexican Railways.

Official reports show that as in most of the Latin-American countries the railroads of Mexico have been built, each one for some special purpose, with little regard to any general plan. Consequently, in some parts of the country two or more roads compete for traffic that is scarcely sufficient to support one, while rich mineral and agricultural sections remain undeveloped because of their isolation.

In 1903 the Government began to buy controlling interests in three of the most important railways of the country, and in 1909 united these three lines under the name of the National Railways of Mexico. This company, in which the Government owned 50.3 per cent of the stock, was gradually extended to include other roads, until it became by far the most important system of the country. Since 1914 this system and practically all the privately owned lines have been taken over and operated by the Government under the name of the Constitutionalist Railways of Mexico. This company owns 6,818 miles of track and controls an additional 1,220 miles.

Progress has been slow but the future is hopeful.

Items of Personal Interest

Mr. R. S. Brown has recently been elected vice-president of the G. M. Basford Company, of 30 Church street, New York, N. Y.

Mr. H. P. Anderson has been appointed superintendent of motive power of the Missouri, Kansas & Texas, with headquarters at Kansas, Tex.

Mr. E. D. Bronner, federal manager of the Michigan Central, has had his jurisdiction extended over the Grand Rapids & Indiana, with headquarters at Detroit, Mich.

Mr. T. J. Clayton has been appointed master mechanic of the Texarkana & Fort Smith, with office at Texarkana, Tex., succeeding Mr. A. D. Williams, resigned.

Mr. J. W. Small, formerly superintendent of motive power of the Seaboard Air Line, has been appointed mechanical assistant on the staff of the regional director of the Southern region.

Mr. S. G. Kennedy, formerly shop foreman of the Atlanta Coast Line, with office at Sanford, Fla., has been appointed general foreman at the Lakeland shops, Fla., succeeding Mr. G. F. Richards, resigned.

Mr. J. C. Garden, formerly master mechanic of the Grand Trunk at Battle Creek, Mich., has been appointed master mechanic of the Stratford, Ont., shops, succeeding Mr. C. Kelso assigned to other duties.

Mr. J. S. Allen, formerly general foreman of the Canadian Pacific, with office at North Bay, Ont., has been appointed division master mechanic of the Sudbury division, succeeding Mr. C. A. Wheeler, promoted.

Mr. F. V. McDonnell, formerly master mechanic of the Pennsylvania Lines West, Northwest system, at Pittsburgh, Pa., has been appointed master mechanic at Fort Wayne, succeeding Mr. E. E. Greist, resigned.

Mr. E. M. Costin, federal manager of the Cleveland, Cincinnati, Chicago & St. Louis, has had his jurisdiction extended over the Muncie Belt railway and the Indianapolis Union, with headquarters at Cincinnati, Ohio.

Mr. R. E. Smith, general superintendent of motive power of the Atlantic Coast Line, with office at Wilmington, N. C., has also been appointed general superintendent of motive power of the Winston-Salem Southbound.

Mr. L. H. Turner, superintendent of motive power of the Pittsburg & Lake Erie, has been appointed superintendent of motive power also of the Lake Erie & Eastern, and the Monongahela, with headquarters at Pittsburgh, Pa.

Mr. George A. Post, president of the Standard Coupler Company, and honorary vice-president of the Railway Business Association, has been elected chairman of the Railroad Committee of the Chamber of Commerce of the United States.

Mr. G. J. Messer, formerly master mechanic of the Sioux City and Dakota division of the Chicago, Milwaukee & St. Paul, has been transferred to the Dubuque division, with headquarters at Dubuque, Iowa, succeeding Mr. George P. Kempf.

Mr. L. Kramer, federal manager of the Missouri, Kansas & Texas, the St. Louis-San Francisco, the Oklahoma Belt, and the West Tulsa Belt, has had his jurisdiction extended to include the Kansas City, Clinton & Springfield, with headquarters at St. Louis, Mo.

Mr. B. L. Wheatley, formerly master mechanic of the Chicago, Rock Island & Pacific, and the Chicago, Rock Island & Gulf, with office at Fort Worth, Tex., has been appointed superintendent of fuel economy of the same roads, with headquarters at Chicago, Ill.

Mr. J. B. Morehead, formerly shop inspector of the Chicago, Indianapolis & Louisville, has been appointed mechanical engineer with office at Lafayette, Ind., succeeding Mr. K. J. Lambert, who has entered the military service in the Quartermaster's Department.

Mr. H. Clewer, formerly superintendent of fuel economy of the Chicago, Rock Island & Pacific, at Chicago, has been appointed regional supervisor of fuel conservation of the Pocahontas region for the United States Railroad Administration, with headquarters at Roanoke, Va.

Mr. M. A. Kleeson, formerly general foreman locomotive department of the Baltimore & Ohio, with office at New Castle Junction, Pa., has been appointed master mechanic of the New Castle division, with office at New Castle Junction, succeeding Mr. A. S. Hodges, transferred.

Mr. A. S. Goble, formerly representative of the Baldwin Locomotive Works, and the Standard Steel Works at Chicago, Ill., has been appointed southwestern district representative of the same companies at St. Louis, Mo., succeeding Mr. C. H. Peterson, transferred to the Chicago office.

Mr. O. P. Prendergast, mechanical superintendent of the Texas & Pacific at Dallas, Tex., has been appointed also mechanical superintendent of the Louisiana & Navigation Company's lines west of the Mississippi, and the Trans-Mississippi Terminal, with headquarters at Dallas.

Mr. A. F. Duffy has been appointed assistant manager of the Safety Section, Division of Operation of the United States Railroad Administration, with office at Washington, D. C., succeeding Mr. W. P. Borland, appointed chief of the Bureau of Safety, Interstate Commerce Commission.

Mr. F. W. Taylor has been appointed mechanical superintendent of the Missouri, Kansas & Texas Railway of Texas, the Wichita Falls & North Western, the Fort Worth & Denver City, the Wichita Valley, the Union Terminal of Dallas, and the Abeline & Southern, with headquarters at Denison, Tex.

Mr. H. C. Eich, hitherto superintendent of motive power of the Chicago Great Western, has had his title changed to that of superintendent of machinery of the same road, with headquarters at Oelwein, Iowa, and Mr. Guy J. Congdon has been appointed supervisor of fuel of the same road, with office at Chicago, Ill.

Mr. F. H. Alfred, federal manager of the Pere Marquette and the car ferry lines in Lake Michigan, has had his jurisdiction extended over the Detroit Bay City & Western, the Ann Arbor railroad, the Detroit & Mackinac, the Port Huron & Detroit, and the Port Huron Southern, with office at Detroit, Mich.

Mr. J. F. Sheahan, superintendent of motive power of the Atlanta, Birmingham & Atlantic, has also been appointed superintendent of motive power of the Georgia Railroad, the Atlanta & West Point, the Western Railway of Alabama, the Charleston & Western Carolina, and the St. Louis, Francisco lines of the Mississippi river.

Mr. William E. Harnisson, formerly assistant master mechanic of the Mahoning division of the Erie, at Brier Hill, Youngstown, Ohio, has been appointed master mechanic, with office at Kent, Ohio, and Mr. Ralph R. Munn has been appointed assistant master mechanic of the Mahoning division, with office at Brier Hill, succeeding Mr. Harnisson.

Mr. G. L. Peck, federal manager of the Pennsylvania, western lines, the Pittsburgh, Cincinnati, Chicago & St. Louis, the Cincinnati, Lebanon & Northern, the Lorain, Ashland & Southern, the Pittsburgh, Chartreis & Youghiogheny, the Calumet Western, the Englewood connecting railway and the South Chicago & Southern, has had his jurisdiction extended over the Ohio River & Western, with headquarters at Pittsburgh, Pa.

Mr. Clarence H. Norton, formerly master mechanic of the Susquehanna, Tioga and Jefferson divisions of the Erie, at Susquehanna, Pa., has been transferred to the Allegheny and Bradford divisions, with headquarters at Hornell, N. Y., and Mr. William Moore, formerly master

mechanic at Kent, Ohio, has been transferred to the Susquehanna, Tioga and Jefferson divisions with headquarters at Susquehanna, Pa.

Mr. C. S. Patten has been appointed superintendent of motive power of the Seaboard Air Line. He entered railway service in 1892 as a brakeman on the Norfolk & Western, and latterly served as foreman and locomotive engineer on the same road. In 1901 he was foreman of engines on the Seaboard Air Line, and latterly as master mechanic, which position he held until his recent appointment as superintendent motive power.

Mr. W. J. Schlacks has purchased the McCord locomotive lubricator and has incorporated the Locomotive Lubricator company for the manufacture and sale of the Schlacks' system of locomotive force feed lubrication, with offices in the Tower Building, No. 6 North Michigan avenue, Chicago, Ill. Mr. O. H. Neal and Mr. C. W. Rudolph, who have been associated with Mr. Schlacks in McCord & Company, have joined the new company.

Mr. Le Grand Parish, at one time superintendent of motive power of the New York Central Lines at Cleveland, Ohio, and now president of the American Arch Company, has been appointed president of the Lima Locomotive Works, Inc., Lima, Ohio, with office at 30 Church street, New York. Mr. Parish has had exceptional experience in locomotive construction, and is one of the leading authorities on railway appliances.

Mr. A. J. Davis, formerly master mechanic of the Erie, with office at Hornell, N. Y., has been transferred to the New York division and side lines, having charge of passenger equipment, with headquarters at Jersey City, N. J., and Mr. Leo R. Lavzine, formerly shop superintendent at Hornell, has been appointed master mechanic of the New York division and side lines, in charge of freight equipment, with headquarters at Syracuse, N. Y.

Mr. J. J. Tatum, formerly manager of the car repair section under the United States Railroad Administration, has been appointed general supervisor of car repairs; Mr. F. P. Pfahler, formerly mechanical engineer of the locomotive section, has been appointed chief mechanical engineer; Mr. John McManany has been appointed general superintendent of equipment, West, and Mr. George N. De Guire has been appointed general supervisor of equipment, East, all with headquarters at Washington, D. C.

Mr. B. J. Feeney, president of the Traveling Engineers' Association, has been appointed supervisor of fuel conservation section for the Southern region, with office in the Healey Building, Atlanta, Ga. Mr. Feeney will give special attention to the conservation of fuel used on locomotives, or shops at terminals, at water stations, and for all miscellaneous purposes, and also report on the preparation of fuel received and its quality, and will make recommendations with respect to its transportation to and its handling at fuel stations. Mr. Feeney's appointment is universally commended among railroad men.

Mr. H. C. Woodbridge has been appointed supervisor of fuel conservation section for the Allegheny region, with office in Broad Street Station, Philadelphia, Pa. Mr. L. R. Pyle is appointed to the Western region, with office at 547 West Jackson avenue, Chicago, Ill. Mr. J. W. Hardy is appointed to the Southwestern region, with office in the Railway Exchange Building, St. Louis. These appointees will give special attention to the conservation of fuel used on locomotives, in shops, at terminals, at water stations, and for all miscellaneous purposes, and also give attention to the preparation of fuel received and its quality, and make investigations and recommendations with respect to its transportation to and its handling at fuel stations.

Mr. Frank P. Roesch, formerly master mechanic of the El Paso & Southwestern,

FRANK P. ROESCH.

has been appointed regional supervisor, division of fuel conservation, United States Railroad Administration, northwestern district, with headquarters in Chicago, Ill. Mr. Roesch was born in Alsace, France, and came to America at an early age, and entered railroad service as a machinist's apprentice on the Rock Island. In 1883 he was appointed roundhouse foreman on the Denver & South Park Railroad at Denver, Colo., since which time he has occupied many positions in the mechanical departments of the principal railroads in the West and Southwest. In 1905 he was appointed manager of the Hicks Locomotive and Car Works, Chicago, and latterly for several years master mechanic of the principal shops of the Southern Railway at Spencer, N. C. Mr. Roesch combines in a high degree the practical and scientific departments of mechanical engineering, and is a writer of marked ability.

Obituary

Charles Allen Goodnow.

Mr. Charles A. Goodnow, vice-president of the Chicago, Milwaukee & St. Paul, died at Seattle, Wash., on July 26, in the sixty-fifth year of his age. Mr. Goodnow was born at Baldwinville, Mass., and entered railway service on the Vermont & Massachusetts as a telegraph operator in 1868. Advancing to dispatcher, train master, and superintendent in some of the eastern roads he was appointed superintendent of construction on the Chicago, Milwaukee & St. Paul in 1886, and in 1902 manager of the Rock Island. In 1903 he became manager of the Chicago & Alton. Returning to the Chicago, Milwaukee & St. Paul, he became identified with the extensive electrification work on that road, and other projects. In 1913 he became assistant to the president, and in 1917 was appointed vice-president, which position he held at the time of his death.

Peter Drummond.

The death is recorded last month of Peter Drummond, locomotive superintendent, Glasgow and South Western Railroad, Scotland. Mr. Drummond had a distinguished career in the mechanical departments of the leading Scottish railroads from 1870, when he entered the service of the North British Railway at Cowlan's locomotive works. In 1882 he was called to the Caledonian railway and became assistant locomotive engineer and works manager at St. Rollox Works, Glasgow. In 1896 he was appointed locomotive superintendent of the Highland railway, and designed several new types of locomotives. In 1912 he was appointed locomotive superintendent of the Glasgow and South Western, where he designed some of the most powerful locomotives in Great Britain.

William H. Newman.

W. H. Newman, formerly head of the New York Central System, died in New York last month. Mr. Newman was born in Virginia in 1847, and entered railroad service in 1869 as brakeman on the Texas & Pacific, and in a few months was appointed station agent at Shreveport, La. In 1883 he became traffic manager of the Southwestern system, and four years later accepted a call from the Missouri Pacific to take the same post with that road. In 1889 he became third vice-president of the Chicago North Western Railway, and in 1896 second vice-president. Two years later he was president of the Lake shore & Michigan Southern, and in 1901 became head of the entire Vanderbilt system at a salary said to have been $125,000 a year. He resigned in 1909.

Traveling Engineers' Association

The annual convention of the Traveling Engineers' Association will be held at the Hotel Sherman, Chicago, Ill., beginning September. The following are the lists of subjects to be discussed: 1. "Fuel Economy," under the following heads: (a) Value of present draft appliances; can they be improved to effect fuel economy? (b) Best practice for handling locomotives at terminals to reduce coal consumption. (c) How can enginemen and firemen effect the greatest saving of fuel when locomotives are in their charge? (d) Whether it is most economical to buy cheap fuel at a low heat value or a higher priced fuel at a greater heat value. (e) The most economical method of weighing fuel when delivered to locomotives, in order that individual records of coal used by enginemen and firemen may be kept. (f) Superheat applied to locomotives as affecting coal consumption.

2. "Engine Failures—causes and remedies, best methods of investigating same, and placing responsibility."

3. "The use of superheat steam in slide valve engines. Drifting, relief and bypass valves or the absence of any one or all on superheat locomotives equipped with piston valves."

4. "Cab and cab fittings on modern locomotives, from the viewpoint of the enginemen."

5. "How can the Traveling Engineer and General Air Brake Inspector best cooperate to improve and maintain the air brake service?" A large attendance of members is expected.

Public to Know the Facts.

A. H. Smith, president of the New York Central, and regional director of the eastern region, in a circular letter recently issued to federal managers and general managers, advises that the public be treated fairly in all matters that require the giving out of accurate, prompt and frank information.

Such a policy will exert a strong influence in promoting harmonious and sympathetic relations between the people and the railroads which they are operating and financing through their government.

Signal Appliance Association

The annual meeting of the Signal Appliance Association was held in New York last month. A new constitution and bylaws were adopted, and the officers and committees were continued until the next annual meeting. There are now 53 members, and applications for membership are being received.

Locomotive Builders' Plants

American railways are now being furnished with about forty locomotives per week, and a much larger number is being supplied to the military railroads in France. The demand continues to grow and the railroad administration is considering the advisability of building new plants or making appropriations to existing locomotive builders to make extensions to their plants. Meanwhile, the principal lomocotive builders are increasing their output.

Old Material

Regional Director A. H. Smith has called special attention to the possibilities in reclaiming old bolts, nuts, locomotive and car parts and maintenance-of-way material, particularly because of the present difficulty in obtaining iron and steel products, and recommends the immediate increase of oxy-acetylene and electric outfits. The close co-operation of all in this matter is requested.

Locomotive Attachments

Automatic fire doors and vestibule cabs are required to be attached to all steam locomotives in New York City Jan. 1, 1919, unless the Director General otherwise order,—that is, all new locomotives coming into service after that date, must be so equipped, and all locomotives undergoing general repairs after the same date must be equipped with these appliances.

Crippled Cars

About 60,000 freight cars, it is estimated, will be condemned for the reason that they are not worth repairing. Not only so, but they frequently cause delays and accidents. The elimination of wornout cars has been aimed at by a number of the leading railroads, and was particularly noted in the operation of the Baltimore & Ohio Railroad, effecting a saving of several hours on the through service.

Women in Railway Service

Steps are being taken to conserve the employment of women in what may be called suitable places only, and at the same time wherever they can be used in order to release men for war service. A woman's welfare section is being organized under Director Carter to see that the conditions under which women are employed are the best that can be provided.

Testing Watches.

A test of watches will be made by the United States Bureau of Standards, beginning September 10, 1918. A considerable reduction is made in the fees chargeable in cases where several watches are submitted. Watches and correspondence should be addressed to the Bureau of Standards, Washington, D. C. Application blanks may be had on application to the Bureau.

Railroad Equipment Notes

The Ann Arbor is inquiring for about 3,000 tons of 85-lb. rails.

The Texas Electric Railway will build repair shops at Denison, Tex.

The Chicago & Northwestern has let a contract for a 20-stall roundhouse at Fond du Lac, Wis.

The Louisiana Western will construct a roundhouse and terminal facilities at Lake Charles, La., to cost $132,000.

The Railroad Administration's order is for 15 additional light Mikado locomotives from the Lima Locomotive Works, Inc.

The Pennsylvania Railroad, it is reported, will soon break ground for a new roundhouse, coal tipple and car shops at Wheatland, Pa.

The Central of Georgia has given the contract for a 300-ton concrete coal chute at Good Water, Ala., to the Ogle Construction Co., Chicago.

The Maine Central it is reported, will build a two-story, 70 by 150-foot pattern shop and a one-story, 20 by 40-foot dry house at Waterville, Me.

The United States Navy, Bureau of Supplies and Accounts, has placed an order for steel flat cars with the General American Tank Car Corporation.

The Baltimore & Ohio has had plans prepared for a four-story locomotive repair shop and freight house to cost $400,000, to be located at Pittsburgh, Pa.

The plans are being made and land is being bought for a large terminal for the Michigan Central, north and east, of Niles, Mich. Shops, roundhouse, yards, etc., to cost $1,500,000 will be built.

The United States Government has given an additional order for 500 Consolidation type locomotives to the Baldwin Locomotive Works, for service on the military railway lines in France.

The Pennsylvania Railroad Lines West has awarded contract to the Austin Co., Cleveland, Ohio, for a locomotive erecting and machine shop, 200 by 420 feet, at Logansport, Ind., estimated to cost approximately $600,000.

The railroad administration advises that at the request of the Chicago, Milwaukee & St. Paul that road will receive 50 heavy Mikado type locomotives instead of lighter engines of the same type it was originally announced would be assigned.

The Illinois Central proposes improvements at Central City, Ky., to include a ten-stall brick roundhouse, an 85-foot turn table, one-story brick power house and machine shop, 100,000-gallon water tank of wood on steel frame, cinder pits, concrete stack, etc.

The Pennsylvania Railroad Lines West has been granted permission by the Railroad Administration to build a new locomotive repair and engine house at Stark, Ohio, to cost about $900,000 and to remodel and improve its shops and engine house at Wellsville, Ohio, at a cost of $276,000.

The scrap yards of the Atchison, Topeka & Santa Fe are reported marketing 200 tons of bar iron. Formerly the Santa Fe made only sufficient bar iron at Corwith to supply its own needs, but by running its mill full, it is understood, it can supply about 800 tons a month more than it can consume.

The Chesapeake & Ohio has let contract to the Arnold Company, 105 La Salle street, Chicago, to erect additions to its car and locomotive repair shops at Huntington, W. Va. The work includes construction of erecting shops for handling Mallet locomotives, addition to blacksmith shop and installation of additional machine tools.

The Pennsylvania Lines West has let a contract for extensive engine terminals at Crestline, Ohio, including a 30-stall roundhouse. Also similar improvements at Richmond, Ind. At Logansport, Ind., this company will erect a machine shop 200 by 420 feet, to be equipped with a 250-ton crane. The improvements at these points will cost about $1,600,000.

The Government has placed orders for 10,000 freight cars for overseas service. The orders were distributed: Pressed Steel Car Company, 500 gondolas and 1,000 box cars; Pullman Company, 1,500 box cars; American Car & Foundry Company, 2,400 cars; Standard Steel Car Company, 1,900; Haskell & Barker Car Company, 1,800 cars; Standard Car Construction Co., 400 tank cars; St. Louis Car Company, 250; Liberty Car & Equipment Company, 250 cars.

Orders for 200,000 tons of rails for use in the extension of the American military railroads in France have been allocated within the past few days. These requirements were distributed as follows: 127,000 tons to the United States Steel Corporation subsidiaries, 25,000 tons to the Bethlehem Steel Company, 16,000 tons to the Cambria Steel Company, 16,000 tons to the Lackawanna Steel Company and 16,000 tons to the Colorado Fuel & Iron Company.

Books, Bulletins, Catalogues, Etc.

PROCEEDINGS OF THE 25TH ANNUAL CONVENTION OF THE AIR BRAKE ASSOCIATION. 275 pages, with illustrations. Edited by F. M. Nelles, secretary, 165 Broadway, New York. Price, $2.

A record of the proceedings of the 25th Annual Convention of the Air Brake Association held in Cleveland, Ohio, May 7-9, 1918, was issued last month and contains the papers submitted by the various committees and the debates on the same, together with the addresses delivered by prominent citizens of Cleveland, and others, all of real interest and value to railroad men generally and air brake men particularly. While it may be a matter of regret to many that a number of conventions are being dispensed with in these strenuous times, it is generally conceded that the convention of the air brake men was indispensable; and the best proof of the vital importance of their transactions will be found in the pages of their annual volumes so carefully edited and finely presented by the worthy secretary, to whom application should be made for copies of the volume.

Westinghouse Instruments and Relays.

Catalogue 3-B, superseding Catalogue 3-B of July, 1916, has been issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., and contains full explanatory data and illustrations of the Westinghouse instruments, including switch board, portable and precision instruments, ammeter shunts, instrument transformers and relays. Interesting facts about the company furnish an idea of the vast enterprise, the chief works at East Pittsburgh alone employing over 30,000 persons, not speaking of the other nine subsidiary establishments in various parts of the country employing many more thousands. It may be added that there are over twenty other catalogues, all setting forth the particulars in regard to the numerous specialties furnished by the company. Railway accessories are particularly dealt with in Catalogue 5-B. Any of the company's catalogues may be had on application to the main office at East Pittsburgh.

MacRae's Blue Book.

This notable advertising publication improves and enlarges year by year and now extends to 1,350 pages, with a perfection of classification not common in advertisink books. The address section furnishes an alphabetical list of all the principal manufacturers of iron and steel products, building materials, etc., in the United States. Of special interest is the section giving the standard list of prices of building materials, and iron and steel products, and is a valuable source of information not usually published. A net discount computer is a handy supplement to this section. The arrangement of the work is excellent and the letter-press is among the best.

Age of Workers Injured

The General Electric Company has made a report on the causes of industrial accidents which shows some interesting facts: Most accidents, in proportion to the number of its employes, occurred to workers between 22 and 26 years of age, and 50 and over; 37 years was the most careful age; 50 per cent. of accidents occurred to employes who had been with the company less than 6 months; more accidents occur on Monday than on any other day, and more in hot weather than in cold. Eighty per cent. of the accidents were due to carelessness; 47 per cent. were due to the handling of materials; 12 per cent. to slipping of tools, such as wrenches, chisels, hammers, etc.; 12½ per cent. to stepping on chips, scraps, nails, etc., or striking some part of the body against some object; 4 per cent. to slipping and falling; 1 per cent. to locomotives, cars or cranes; 1 per cent. to electrical shocks and burns, and the remainder to miscellaneous causes.

Analyses of Coal

Bulletin 123, issued by the Bureau of Mines, presents analyses and descriptions of samples of coal collected during the fiscal year 1913 to 1916. Nearly 500 pages are occupied in the description of the methods of sampling and tabulation of results. As a ready index of the qualities of the various kinds it is reliable and should be of much service to all interested in coal consumption. Copies of the Bulletin may be had from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 50 cents.

Reactions

The quarterly publication issued by the Metal & Thermit Corporation, 120 Broadway, New York, for the second quarter of the current year, contains a number of articles describing and illustrating welds in some of the leading railroad shops, all of which are remarkable from the viewpoint of complexity of fracture. As a sample, a cast steel locomotive driving wheel with no less than five separate fractures was successfully repaired at Knoxville, Tenn., on the Southern railway. In view of the difficulty of securing a plentiful supply of steel castings, thermit welding is rapidly growing in favor. Catalogues furnished on application to the company.

New Type of Boiler

A foreign publication describes a boiler in which the firebox is provided with vertical corrugations and the front ring of the barrel is corrugated like the Samson-Fox furnace tube used in Lancashire boilers. The smokebox itself is not riveted to the extreme end of the barrel in the usual way, but is riveted to the back end of the corrugated length of barrel, and to the front end of the second ring from the front, three plates being held by one row of rivets. The makers claim that the tubes remain in good condition much longer, as free expansion lengthwise is allowed by the length of corrugated barrel.

Safety First

A report of the California Railway Commission is being used frequently to show the carelessness of people even with all the "Safety First" urge. Sixty-nine per cent. of the many thousand drivers who were observed crossed the tracks without halting or looking to right or left. Three per cent. looked one way. Twenty-eight per cent. only looked both ways. Forty-nine per cent. of the pedestrians looked neither to right or left, 15 per cent. looked one way and 36 per cent. looked both ways. Eternal vigilance is the price of life and limb, as it is of liberty.

—W S S—

A Thrift card in your pocket beats a dozen flags on the lapel of your coat.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXI | 114 Liberty Street, New York, October, 1918 | No. 10

Gasoline Traveling Crane for Railroad Ash Pits

The science of railroading is a progressive science, in which new ideas, new procedure and new appliances are being brought forward, and worked and tried and subjected to the severities of the "road test." Those that survive are proved to be useful and those that fail are eliminated, or modified and built over. The whole process is analogous to natural selection with its harsh corollary, the "survival of the fittest."

Not long ago the New York Central, in the van of progress, secured some gasoline operated traveling cranes for use on ash pits, and for slight but necessary jobs about the roundhouse yard. According to the books of the makers, the N. Y. C. Lines have eleven of these cranes in service and five on order not yet received. The P. R. R. have ordered four, and the Boston & Albany have two coming to them. These cranes use gasoline, kerosene, or distilate, which is a light fuel oil. The gasoline used approximates 1/10 of a gallon per H. P.-hour, and kerosene about 1/7 of a gallon per H. P.-hour. It takes about 3 gallons of gasoline per hour to run a 30-H. P. crane in continuous operation and about 4 gallons of kerosene for the same machine in the same time.

In making use of the gasoline motor for this service the N. Y. C. is not open to the imputation of disregarding the President's recently expressed wish for the conservation of gasoline, which has eliminated joy-riding in automobiles on Sunday. The railway must have engines expeditiously handled, and ashes removed and some kind of power is required for this necessary work. If steam is used, coal must be burnt, and burnt almost continuously, because even when not at work, a steam crane must keep up steam. With the gasoline crane when a slack time comes the fuel is shut off, none is used and the crane is dead, but can be brought to life as easily as one starts a motor car. The slack time with the gasoline crane, liberates the crane man for other work as he has no bed of burning fuel to take care of, and nothing to do on the crane. If for winter some non-freezing liquid be used for the radiator the crane can be left in the side track and no harm come to it.

At East Buffalo on the N. Y. C., that railroad handles in the neighborhood of 4,200 locomotives a month or about 142 in the 24 hours. The gasoline crane has not been used at night and only intermittent work is required in the day, and then only is fuel necessary. The crane moves itself and can handle a car or two in addition, so that the ash handling becomes, as it were, a self-contained subsidiary industry in the mechanical department, as it does not call for outside assistance when minding its own business. Light yard work can also be done by the gasoline crane such as picking up material, loading or unloading it and if rubbish or other material be collected and piled up, the clam-shell bucket of the crane can lift it and place it where desired.

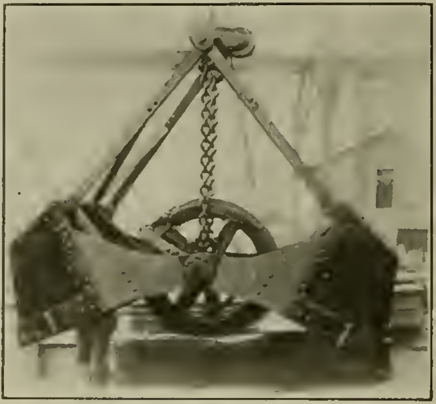
GASOLINE CRANES USED FOR HANDLING COAL, ASHES AND MATERIAL, N. Y. C. LINES.

The crane sweeps round in a circle arranged for 15 ft. spacing of track and can turn a full circle. The cab is only 12 ft. 7 ins. high, 9 ft. wide, and swings on a radius of 8 ft. 9 ins. The reason which gives this crane its gaps in the working day, when the man in charge can be employed with advantage elsewhere by the railway is found in the speed of operation. The approximate swing in ordinary work is through a circular of

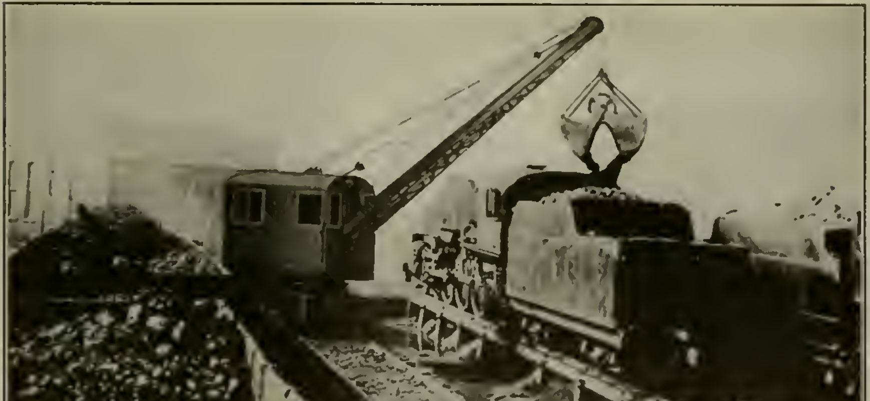
90 degs. The bucket which weighs about 2,800 lbs. and holds 1,000 lbs. of coal or 600 to 700 lbs. of ashes, can be closed in 5 sec., hoisting 12 ft. in 6 sec., finishing the hoist and slewing the load 9 sec., dumping 3 sec., return slewing and opening the bucket 7 sec. total of 30 sec. Thus making 2 cycles movement per minute. Coal is lifted, when that is handled, at 20 ft. radius and ashes at 25 ft., on account of the differing weighs of load and positions of the loading and discharging points. The minimum radius of the crane is 10 ft., and the maximum is 25 ft., and is variable between these limits by the use of the radius varying appliance with which each crane is equipped.

The operation of this crane does not require the services of a skilled man, an intelligent and handy laborer can be employed. The tractor motor is of rugged type, intended for hard usage and is approximately from 30 to 35 H. P., fitted with automatic governor to maintain constant speed, and the various motions are controlled by friction clutches. Between 50 and 60 tons of coal can be handled in an hour, and 42 tons of ashes in the same time. The difference between coal and ash handling is not due to slower crane operation, but is on account of the fact that the bucket though full in each case contains a greater weight of coal than it is possible to be carried by the same bucket as bulk for bulk the ashes is much lighter than the coal.

The crane has all the essential features for general crane service and aside from bucket work, can be applied to any other use within its capacity. When electric operation is desired instead of gasoline it is possible to make the necessary change without disturbing essential features. The crane car is 6 ft. long and 7 ft. 4 ins., wide. The car is mounted on four wheels. The driving gear attached to the axle is cast steel, of heavy pattern and made in halves to facilitate repairs. The journal brasses are removable, and the propelling shafts are babbitted in their bearings. The wheel base is 5 ft. 2½ ins., and the crane operates on a minimum track curvature of 60 ft. Both axles are connected with the propelling mechanism. The engine is supported by two heavy channels that run from frame to frame. The motor is of a type that has been tested in service and found successful. Fuel consumption is very low, and as a result of its sturdy construction, repairs are almost negligible. The engine is a 4-cylinder, 4-cycle motor with 5 ins., bore and 7½ ins., stroke, and is rated at 30 to 35 H. P. at 650 revolutions a minute. The governor is of the flyball type with variable speed, direct connected with the butterfly in the carburetor and governs within 5 per cent. of normal from no load to full load. The operator does not have to adjust the mixture for varying weather conditions.



CLAM-SHELL BUCKET USED WITH GASOLINE CRANE.



GASOLINE CRANE HANDLING ASHES, N. Y. C.

Raising the boom is accomplished by using a train of cut steel spur gearing from the intermediate shaft. This motion is positive, and easily controlled by means of a cone friction clutch operated by a hand lever. A foot brake with ratchet pawl is also provided. The boom is lowered by gravity and is controlled by a foot brake. The motions of slewing and propelling are not independent of each other. They cannot be performed together. Whether the crane rotates or travels depends on whether the rack is locked or free. Slewing or traveling in either direction is controlled by a single hand lever operating two friction cone clutches on an intermediate shaft. The backs of these two clutches are integral with bevel gears actuating a large bevel on top of the vertical slewing and propelling shaft which is babbitted in the base casting. This shaft projects below the base casting and carries a spur gear meshing with the rack.

Slewing is accomplished by locking the rack to the mast by means of a toggle friction operated by a lever. At all times except when desired to propel, the rack remains locked to the mast. Involuntary slewing when traveling is prevented automatically by a lock. The crane has sufficient power to slew at three to four revolutions a minute with loads.

For traveling, the operation is the same as for slewing, except that the toggle friction locking the rack is released and the revolving part of the crane becomes automatically locked in position. Only one hand lever is required to perform this double function. The rack then becomes an idler which transmits power to a vertical propelling shaft in the car body, and thence to both axles. The propelling speed is approximately two miles an hour.

The levers actuating all motions are arranged for easy handling from the operator's platform. This is forward on the right hand side, where the man has a clear view of his work at all times. The boom is made of two channels latticed with bars and tie plates and furnished with castings for the pin connections on the base casting, and also reinforced to carry the pins for the sheaves at the end of the boom. It is approximately 27½ ft. long and is furnished with a 5-ton hook and a 3-part block. The crane has an overhead clearance of 12 ft. 6 ins., when the boom is in the lowest position. The rear end will slew within a circle of 8 ft. 9 ins., radius from the center of revolution.

With a standard 27 ft. 6 ins. boom, at a radius of 20 ft. the center of the sheave at the end of the boom is 24 ft. above the rail. When the crane is swung at right angles to the track, there is no part of the car or of the rotating structure except the boom, extending beyond the rail in front of the crane. This provides ample room for handling bulky loads at short radii.

The ballast required for the crane is 1,000 lbs. of scrap in the rear extension, and 3,000 lbs. of scrap in the car. The weight in full working order, including a full radiator of water, but without a

bucket, is approximately 41,270 lbs. as we said above, the bucket weighs about 2,800 lbs. The shipping weight of this crane, including a radiator full of water, but without the bucket, is 37,270 lbs. This crane is coming into favor with the railroad officials and the makers, The Industrial Works of Bay City, Mich., are receiving many inquiries. The economical features of its operation, its "rests" during the day, while it performs all that is required of it, and it is able to liberate a workman part of his time, for other work, its elimination of night work, and the fact that when wanted, no delay getting up steam is present, causes it to be looked upon as a step in the right direction, and an advance over hitherto regularly pursued methods. It is an attempt to put a substantial economy into operation, and is an advance.

Camouflage In Nature and In War

Camouflage is not new, except in its modern application to war. Nature has her subterfuges and her efforts to deceive. The struggle for existence has, in some aspects, a likeness to war. Mimicry is one of the tricks played, so that one species may cheat, and survive against the attacks of another species. Warning colors are often employed by an individual of one species, to advertise to its enemies that it is unpalatable, or has an evil odor, or maintains a sting or a poison gland. It makes known to its adversaries that its destruction or injury will be attended with most unpleasant consequences.

This is an aggressive phase of protection by coloration or form. It warns enemies before they attack. In war, the only parallel we have to this form of aggressive mimicry, is that which is solely intended to protect, and in no case to assail an enemy. This is the red cross marking on hospital ships and buildings. They are so marked, very conspicuously, that they may make known their whereabout and their employment. It does not even hint at reprisal or evil consequences. This is in accordance with the international agreement, drawn up at Geneva in 1863, and Germany was one of the official signatory powers to that agreement, as well as to the treaty guaranteeing sovereign rights to Belgium. The red cross on a white ground, was the designation devised at the time, in complement to Switzerland, whose flag is a white cross on a red ground. The humane symbol consists in reversing or counterchanging, the colors of the Swiss flag. The cross does not reach the border of the flag and in making the red cross emblem, it is necessary to see that it is everywhere surrounded by a broad strip of white. This constitutes the official badge; the "red cross." The conspicuous marking of hospital ships and buildings to designate their use, puts them in a class by themselves, and the sinking of hospital ships, against the existing Geneva rules, in no way aids military advantages, while it constitutes one of the deepest crimes against Christian humanity, and stands out marked with its black-hearted abrogation of the laws of God and man, that the barbarous hordes of Germany have ever dared to commit.

Camouflage, however, is Nature's way of masquerading as one thing, while it is really another, or in hiding its predatory character in order to gain a legitimate yet subtile advantage. The Oriental tree-shrew is a beast of prey, but it so resembles the harmless squirrel that birds allow it to approach, because they mistake it for the vegetable-feeding squirrel, and so fall victims to its predatory habits.

The camouflaging of trains, ships, guns or the whole paraphernalia of war, does not outrage any moral code, nor does it violate any known law. It is perfectly legitimate, it follows from what Nature has taught us she does herself. One of the animal or insect kingdoms of our planet, from the necessities of the case, and from the inside of its being, seems to touch the exterior of another domain. The marking of the wings of moths often shows the effort to pass unnoticed. The shamming of death by some species of insects on the approach of danger, is not a conscious piece of acting on their part, but is the paralysis of fear, which causes the individual to lie motionless and so escape notice. Immobility is in itself a camouflage of the greatest efficacy.

In the case of railway trains the absence of motion, however good it may be theoretically, is out of the question. The irregular marking, and the contrast of

AMERICAN BUILT BOX CAR BEING CAMOUFLAGED; SOMEWHERE IN FRANCE.

colors is relied upon to confuse the observer and render attack from aircraft more difficult for the enemy, and it causes the aiming of guns to be less accurate. The outline of the train is so blurred or the whole thing is mistaken for something that it is not, even if it is seen, that it may become practically safe. It so happens that a species of spider, which is good bird-food, closely resembles an ant, which is not. The spider is so modified in body-form and by its holding the front pair of legs up to represent antennæ, or "feelers," that it frequently escapes attack. Although this spider may be seen, its true nature is not apprehended. A species of tree-hoppers (membracid) is entirely unlike the ant, yet it carries on its back an ant-like shield, and when looked upon from above, it appears to be wholely an ant, which it is not by any means.

In the case of war camouflage, the effort made, outside the conspicuous marking of red cross ships and hospitals, is to render the object most difficult of discernment, or if seen at all to blur or obscure its outlines, or in fact, to hide it, or distract the attention of hostile airmen or observers. A moving train, if traveling over ground which it resembles, or beside or under the branches of trees, to which it approximates in hue, the engine emitting very little, light-colored smoke, and where steam leaks are reduced to a minimum; the whole presents a confusedly unusual mingling of color, and of light and shade traveling at what looks from a great height, as a snail's pace; must have in its coloration, and vagueness of outline, and apparently slow motion, a means of appearing, to distant hostile observers, as that which it is not. So conventionally educated has man's mind become in the lapse of years, that a deviation from looked for and expected coloration, has a misleading and confusing effect on the eye, however well informed the mind may be. Part of the protection of the camouflage is psychological, and it is a perfectly fair "ruse de guerre" to exploit the protective features of bizarre coloration to their fullest extent.

When one considers the object of the camouflage, aside from the aggresive phase, spoken of in a previous paragraph, and especially of a moving train, where absolute stillness is unknown, we may begin to appreciate value of the end in view. It is not the production of low visibility that is aimed at so much, as it is the ability to confuse the enemy. This is done by what is called in Great Britain, the "dazzle system" of painting. The aim here is not to conceal the car or train, but to so mottle it, with contrasting light and dark color as to obliterate its familiar outlines.

When this is done it is liable to cause an error of judgment on the part of a hostile gunner, because he cannot accurately gauge distance, or the size of the object or its rate of motion. The irregular pattern of the camouflage painting furnishes a degree of protection under widely differing conditions. The pattern contains dark patches of color which blend with the landscape, and light areas which blend with the sky, so that on whatever background the train is seen its outline never presents definite, clear-cut, lines. The difference between the "dazzle system" and the low visibility camouflage is that a train painted a uniform color, even naval gray, or pure white—which are good colors for the purpose—is that the contour becomes definite, but with the "dazzle system," the outline is purposely made to appear indefinite and looks blurred and vague, and its distance from a hostile airman or gunner on the ground, becomes, for them, largely a matter of conjecture. It is like a man clutching at a stick in the water, without being able to realize that the refraction of the image in the denser medium, so distorts the apparent position of the stick that his eye and hand fail to cooperate, and a mere guess is forced on him by the perplexing object, so it is in war. Mr. E. L. Warner says that with regard to ships, one that is properly camouflaged stands a 10 to 20 per cent better chance of escaping an enemy submarine than one not so protected. It seems fair, therefore, to believe that a camouflaged train has a very much better chance of escaping aircraft or artillery hits than one which is painted a uniform color, even if it adds to low visibility.

The war was forced upon us, it is part of a deep-laid plot which had for its object the unrighteous spoliation of peaceable nations because of the ambition of one incapable man whose mind sought power, which he has shown no ability to wield. The whole German empire and its mendacious ways and works, has been a forceful example of the most daring subtle, sinister and wicked effort at camouflage, mental, moral, and physical, that the world has ever seen; and now that the concealment is destroyed, it is known to be what it is. Let us beat it at its own game—the camouflage of war, as we are beating this German thing down, with our victorious armies now on the road to vulturous Berlin.

Passenger Car Cleaning.

A short time ago a paper was read before the Canadian Railway Club on the subject of "Passenger Car Cleaning." The speaker pointed out in his remarks, a few of which we give, that before cleaning can begin some of the cars must be fumigated, which is done once a month; upper berths have to be opened, and blankets, pillows, berth curtains and mattresses spread out so that the fumes will penetrate every part of the equipment; locker doors and toilets must be opened and all windows and ventilators closed. For an ordinary fumigation one sheet is used, saturated with formaldehyde, and hung up in the center of the car; the car is then closed up, locked and left for at least one and one-half hours; after which it is opened and ventilated for the cleaners to go in. For a thorough fumigation, which is used in cases of actual infection, three sheets are used saturated with formaldehyde and hung up, one in each end and one in the center of the car, and car left closed at least three hours. After which it may be opened and ventilated.

The interior of the car is cleaned from the headlining to the floor. First the dust is got rid of, then deck sash are opened and dust wiped out with a disinfectant solution in the water, dust is got out from between and above the window sash by hammering with the hand and window sticks covered with a cloth. When all the dust that can be removed is out, the floor is swept. Then the headlining is washed, including the deck sash down to the deck sash rail.

The baggage and express cars come next. The fish racks are lifted and the pits are swept out and then rack and pits are scrubbed with clean water, but without disinfectant; then the pits and racks are sprinkled with lime and the racks are replaced. As necessity requires these cars are washed down from roof to floor, as they are on the front end; they get very dirty from smoke from the locomotive. The reason that disinfectant in the water for scrubbing baggage cars is not used, is that it would taint some of the commodities carried.

Mail cars are cleaned in the same way, except that the floors are scrubbed with disinfectant in the water. This completes the inside cleaning. The outside is cleaned by washing or wiping one or other is done, according to weather conditions.

War Industry Must Spread.

As a means of relieving congestion of traffic lines and of manufacturing conditions in the northeastern portion of the country, the War Industries Board, the United States Fuel Administration and the United States Railroad Administration announced, on June, 1918, a policy of limiting new production within this district. The congested area comprises the New England States, Eastern and Southeastern New York as far west as Binghamton, Pennsylvania as far west as Williamsport, Altoona and Harrisburg, all of New Jersey, all of Delaware and Eastern Maryland, not including Baltimore. War industries must spread west and south.

Our Individual Part

The Fourth Liberty Loan drive, which began September 28, offers a great opportunity for concerted action and for individual action, and the loan will be a success if we all do our part.

Pacific or 4-6-2 Type Locomotive for the Central Railroad of New Jersey

Six large Pacific type locomotives, designed for fast passenger service, have recently been built by the Baldwin Locomotive Works for the Central Railroad of New Jersey. These locomotives have driving-wheels 79 ins. in diameter; and with 26 x 28-inch cylinders, and a steam pressure of 210 lbs. The maximum tractive force exerted is 42,770 lbs. As the weight on drivers is 181,400 lbs., the ratio of adhesion is 4.24. The locomotives are therefore able to cope with heavy trains, while at the same time their proportions fit them for sustained running at high speed.

The boiler is of the Wootten type, with a conical ring in the middle of the barrel, and a combustion chamber 36 ins. long. Flexible bolts are used exclusively in the throat, sides and back-head, and in the water-space under the combustion chamber; and three rows of expansion stays support the forward end of the combustion chamber crown. The grate is composed of three groups of rocking bars, each group being arranged to shake in two sections; and separating these groups are two groups of drop-plates, which run lengthwise of the firebox. With a grate area of 94.8 sq. ft., this firebox is suitable for burning either lump anthracite, or a mixture of fine anthracite and bituminous coal. There are two, round fire-doors, whose centers are 38 ins. apart measured transversely.

The reciprocating and revolving parts are comparatively light in weight, and are of a design which is specially suitable for a high-speed locomotive. The piston heads are steel castings of dished section, fitted with gun-iron bull-rings bolted on. The packing rings are also of gun iron, and are of the Dunbar type set out by springs. Gun-iron is also used for the cylinder and steam chest bushings, and for the valve bull rings and packing rings. The last named are turned with a shoulder, to keep them from working out, in case of breakage. The piston rods are of heat treated steel, hollow-bored. The cross-head is a one-piece steel casting, with a wide shoe on the top, which is babbitt lined and slides in a box-shaped guide. It has a short depending lug, to which the union link of the Walschaerts valve gear is attached. This style of cross-head has a comparatively small bearing area on the guide when backing up, but this need not be considered a disadvantage on a fast passenger locomotive. The cross-head pins and main crank pins are hollow-bored. A light design of valve gear is used, with the pins working in phosphor bronze bushings. The gears are controlled by the Ragonnet type "B" power reverse mechanism.

The main frames are of most substantial construction, as they are 5½ ins. wide, and have a depth of 7½ ins. over the pedestals. The pedestal shoes and wedges are of gun-iron, and the shoe and wedge bearing surfaces of the driving-boxes are fitted with phosphor bronze liners. The Commonwealth rear frame cradle is applied, in combination with the Cole design of trailing truck.

The tender has a one-piece, cast steel frame, and is equipped with an air-operated water scoop.

Further particulars are found in the table of dimensions, which we give below:

The gauge of the track is 4 ft. 8½ ins.; cylinders, 26 ins. x 28 ins.; valves, piston, 13 ins. diam. Boiler—Type, wagon-top; diameter, 78 ins.; thickness of sheets, 13-16 in. and ⅞ ins.; working pressure, 210 lbs.; fuel, fine anthracite; staying, radial. Fire Box—Material, steel; length, 126⅛ ins.; width, 108¼ ins.; depth, front, 81¼ ins.; depth, back, 60½ in.; thickness of sheets, sides, back and crown, ⅜ ins.; thickness of sheets, tube, ⅝ ins. Water Space—Front, 5 ins.; sides and back, 4 ins. Tubes—Diameter, 5⅜ ins. x 2 ins.; material, 5⅜ ins., steel; 2 in., iron; thickness, 5⅜ ins., No. 9 W. G.; 2 ins., No. 11 W. G.; number, 5⅜ ins. are 36; 2 ins. are 252; length, 19 ft. 0 ins. Heating Surface—Fire box, 236 sq. ft.; combustion chamber, 67 sq. ft.; tubes, 3,454 sq. ft.; total, 3,757 sq. ft.; superheater, 816 sq. ft.; grate area, 94.8 sq. ft. Driving Wheels—Diameter, outside, 79 ins.; diameter, center, 72 ins.; journals, main, 11½ ins. x 14 ins.; journals, others, 10½ ins. x 14 ins. Engine Truck Wheels—Diameter, front, 36 ins.; journals, 6½ ins. x 12 ins.; diameter, back, 48 ins.; journals, 9 ins. x 14 ins. Wheel Base—Driving, 13 ft. 10 ins.; rigid, 13 ft. 10 ins.; total engine, 35 ft. 8 ins.; total engine and tender, 72 ft. ¼ ins. Weight—On driving wheels, 181,400 lbs.; on truck, front, 50,600 lbs.; on truck, back, 59,400 lbs.; total engine, 291,400 lbs.; total engine and tender, about 460,000 lbs. Tender—Wheels, number, 8; wheels, diameter, 36 ins.; journals, 6 ins. x 11 ins.; tank capacity, 9,000 U. S. gals.; fuel capacity, 12 tons; service, passenger.

CENTRAL RAILROAD OF NEW JERSEY NEW PACIFIC (4-6-2) ENGINE FOR PASSENGER SERVICE.
C. E. Chambers, Supt. Motive Power. Baldwin Loco. Works, Builders.

Inventors—Attention

Any person desiring to submit any apparatus or device to the United States Railroad Administration at Washington for the purpose of having it passed upon and investigated should forward complete specifications and detailed drawings, drawings not larger than 8 by 10½ ins. are preferred, and not to be returned. Correspondence relating to locomotives and cars should be addressed to Mr. Frank McManamy, assistant director, division of operation, Washington, D. C. Appliances in regard to roadway and track should be addressed to Mr. C. A. Morse, assistant director, division of operation, engineering and maintenance, Washington, D. C. This arrangement has the effect of separating departments.

Twenty-Sixth Annual Convention of the Traveling Engineers' Association

The annual convention of the Traveling Engineers' Association was held in Chicago, Ill., beginning on Tuesday, September 10 and continuing for the succeeding four days. The attendance was unusually large. The approval and support of the Administration gave the meeting a degree of increased interest that attracted many leading railroad men other than the members. President P. J. Feeney presided, and in the course of an opening address referred to the increase in membership and the very substantial financial condition of the Association. Mr. Feeney alluded to the fact that great responsibility devolved upon the members at all times in supervising locomotive service, and at the present time more so because a unity of purpose and an earnest concentration of effort was essential in order that the most important factor in transportation, the motive power, should not fail the government in the great national emergency in which we were all involved.

Mr. Frank McManamy, assistant director of operation, United States Railroad Administration, followed in an address setting forth with remarkable clearness the action of the government in assuming control of the railroads, a responsibility which it did not wish to assume. The railroads were placed under federal control because in the crisis brought about by the war they had practically ceased to function under private management. That this condition was recognized by the leading railroad men of the country before the government made any step towards taking over the railroads, is evidenced by the fact that a subcommittee of the Council of National Defense attempted for some time before the railroads were actually taken over by the government to operate them as a national system or a single unit. This plan did not fail because of lack of ability on the part of the men in charge of it, because they were considered the ablest in the railroad field; it failed because no organization with less authority and power than the Federal government could control and direct such a huge work as the nationalization of the American railroads.

The question is no longer, can the Government successfully operate the railroads, because that has already been demonstrated, the only question now is, how big a success is it going to be. That question will be largely determined by the spirit in which the principles laid down by the President and the Director General are carried out and no body of men can do more to aid in carrying out those principles than the members of the Traveling Engineers' Association.

Everyone knows that we are in this war to win and that we are going to win, and the splendid reports of the work of our boys in France leaves no doubt in anyone's mind as to what they are doing and are going to do; but the thing that railroad men here must realize is that they are an essential part of the American Expeditionary Force; that they are truly a part of the American Army; that they have an important link in the chain of communications with the front to maintain and to operate successfully and that a failure of any part of our transportation system is the only thing that can possibly endanger the success of the Allied cause.

Mr. F. Roesch, of the El Paso & South

P. J. FEENEY.

Western, and recently appointed supervisor for the fuel conservation section, in the Northwestern region, presented the first technical paper before the committee on the subject.

HOW CAN THE TRAVELING ENGINEERS AID THE RAILROAD ADMINISTRATION IN THE MAINTENANCE OF LOCOMOTIVES?

In the course of his address Mr. Roesch stated that there were at present fifty federal inspectors to cover two hundred and fifty thousand miles of railroad. When we look back and see what these fifty men have accomplished toward improving the general condition of all the locomotives in the United States, we can appreciate what thirteen hundred traveling engineers working along the same lines can do. But that is not all. The traveling engineer can, by his example, multiply himself fiftyfold, after having convinced yourself that you are working for the U. S. A., and not the X. Y. Z. railroad, line up the men under your supervision the same way. Show your men that all locomotives are U. S. A. locomotives and that it is their duty to get the very best there is in them out of them. That when lying on sidings waiting for other trains, they should, if they would deserve the name of enginemen in every sense of the word (and at this time that includes unqualified loyalty) get down and inspect each his engine, tighten up any loose nuts or bolts they may find, put a nail or piece of wire in place of any missing cotter or split key, fill a grease cup or set up a wedge, if necessary, or do anything else that they can do to help matters along, regardless of any contracts or agreements they may have with the company relieving them on this duty. And more yet, have them make notes of any defects found that they cannot repair, and report same on arrival even though they are not required to make work or inspection reports.

In the course of the discussion that followed the presentation of Mr. Roesch's paper Mr. H. M. Curry, mechanical superintendent of the Northern Pacific called particular attention to the greater need of keeping the equipment in a presentable condition, as an improved appearance is always certain to receive better consideration at the hands of those operating it than might otherwise fall to its lot, and that because of this fact, great economy and care of maintenance will ensue. Mr. I. B. Hurley of the Wabash, referred to the proper maintenance of the driving gear of the locomotive as one of the fundamental and practical phases over which the traveling engineer has immediate influence. Lacking proper attention to the matter of binder and wedge adjustments, driving boxes become worn, crown brasses are loosened, rod and pin bearings are distorted and the whole mechanism of the locomotive generally is demoralized. Close attention to these parts by the traveling engineer with reports on same to the maintenance forces are held to be a vital feature in the keeping of locomotives in satisfactory running condition.

Mr. Joseph Keller presented the report of a special committee on

SUPERHEATER LOCOMOTIVE PERFORMANCE

in the course of which it was stated that parts of superheater locomotives which may affect economy should be very carefully watched for proper size and adjust-

ment. Air openings in ash-pans on many locomotives are insufficient. Grate designs are not adaptable to the kind of fuel burned. Exhaust nozzle size and location bear a direct relation to fuel economy. Front end arrangement and adjustment, with special attention to the prevention of steam or air leaks, furnish opportunity for improvement in many cases. Stack design, size and location, can be given closer attention with profitable results. Many other items might be enumerated, constituting things that it is more convenient to get along with than to correct, as the engine probably runs satisfactorily to those who do not have the owners' interests particularly at heart. Attention to them, however, would increase the earning power of the machine for the operators and move more freight. The superheater is made of the best materials obtainable, from designs that are the results of long experience; it requires a minimum of attention to keep it in good condition. If it is not given this attention, the superheater may be injured; but the performance of the locomotive certainly will be injured.

The direct result of not keeping the flues clean is the shutting off of part of the hot gases from reaching the superheater units and also the evaporative surface of the flue; the amount of superheat in the steam falls off and the effective performance of the locomotive is reduced. If the flue becomes completely stopped up, the effect is aggravated. One large flue of a 25-unit superheater locomotive stoppel up in this way, reduces the capacity of the superheater 4 per cent, and the total superheating capacity falls off 4 per cent more for every additional plugged flue. There should be no need of a remedy for this condition; what is required is a preventative. Thorough, systematic, regular cleaning of all flues, large and small, obviates the difficulties resulting from plugged flues. Spasmodic half-hearted poking with a rod at one or two flues which appear to be the worst, is not flue cleaning. Correct flue cleaning must be a matter of shop routine.

After referring to the importance of maintaining tight joints between the superheater units and the heater, and the effect on locomotive performance of steam leaks on the front end, and other details, Mr. Keller pointed out the pernicious effects of high water, particularly in locomotives equipped with superheater appliances. The water should always be carried as low as the service conditions will permit. It should be impressed on hostlers and others who move locomotives around shops and terminals that floating the boiler is bad practice. It will result in water going over into the superheater under conditions favorable to the formation of scale, besides adding to the tendency to leaky units, and a falling off of the performance of the locomotive when it is on the road. The discussion brought out strong endorsements of the committees reports and a strong recommendation of a more general use of the pyrometer on testing the degree of efficiency in the superheater.

At a subsequent session the meeting was opened by an address by Mr. Robert Quayle, general superintendent of motive power of the Chicago & Northwestern. The traveling engineers were reminded that in the stress of the present great national emergency the most exacting service of which they were capable is not too great for them to render and that at the best it was but small compared with that being made by those who have heroically gone to maintain the rights of our common humanity overseas.

Mr. E. Hartenstein, Chicago & Alton, read the report of the Committee on

FUEL ECONOMY

The views of the committee were summarized in twelve specific suggestions as follows:

1. The selection of fuel that is clean and of as high a heat value as can be obtained on the line of road or as close to the line of road to be supplied as possible.

2. All fuel should be inspected to see that it is reasonably free from slate, sulphur, shale bone and other impurities that are non-combustible. Such impurities only take up room in cars, coal pockets and on tenders that should be occupied by clean coal, helps to fill up the firebox and form clinkers which in turn are responsible for engines failing for steam and delays that thoroughly disorganize dispatching, keep crews out on the road many hours after they should have arrived at the terminal and in many cases cause crews to be tied up between terminals on account of the hours of service law. In addition there is the effect of dirty, clinkered fires on firebox sheets and boiler tubes.

3. Locomotives should be equipped with modern fireboxes with brick arches and combustion chambers so that when coal is applied to the fire the gases that are given off will burn and aid in steam making instead of passing out to the atmosphere unburned. To provide for this there should be ample provision for the admission of sufficient air to produce proper combustion. In a paper read by J. T. Anthony before the Central Railroad Club at Buffalo, he states that increasing the firebox volume is generally accompanied by an increase of heating surface, but the increase in surface is incidental to the increased volume and it is the volume that is responsible for the increase in radiating surface and increased firebox evaporation. The installation of a combustion chamber results in an increase of both volume and heating surface, but the added heating surface is of little value if the firebox volume is not to be utilized and filled with the flame. With a restricted air opening or a heavy fire, much of the fixed carbon is completely burned to carbon-monoxide and this combustible gas must then be burned in the space above the fuel bed, in addition to the hydro-carbons. With a fair grade of bituminous coal under ordinary firing methods, fully 50 per cent of the heat generated in the firebox is due to the burning of combustible gases above the fuel bed, and in order to burn them completely it is necessary to have an adequate supply of oxygen above the fuel bed. The more intimate the mixing of the gases and the greater the supply of oxygen, the quicker will the flame burn and the shorter will be its length; otherwise combustion is apt to be incomplete. It is therefore apparent that to produce perfect combustion, it is as necessary to provide for air above the fuel bed as below.

4. Coal should be prepared by having it broken to the proper size for firing and thereby eliminate the wasteful habit of some firemen of throwing large lumps of coal into the firebox or throwing them off along the right of way.

5. It has been the habit of a large number of roundhouse foremen on many roads to fire up engines as soon as it is seen that whatever work there is to be done on an engine is near enough done that they may accept an order for the engine, regardless of whether the engine is ordered out or not. Almost any engine can be gotten ready for service, even after a washout, in not to exceed one hour and thirty minutes, and no engine should be fired in excess of this amount of time before a call and thus avoid engines standing with fire and under steam waiting for a call. Some yardmasters are also prone to order engines when they know the train to be handled will not be ready on the call, and sometimes hours elapse before such trains are ready, but the engine is burning coal all the time.

6. In coaling up engines at terminals or at coaling stations along the road, care should be taken in regard to overloading tenders, as this is not only wasteful, but very dangerous to employes and others. Coal chutes should be installed of a design that tenders can be coaled without the liability of trouble with the chute that would cause coal to be spilled on the ground. Coal that is spilled on the ground should be kept cleaned up and not allowed to accumulate as is the case at many coaling stations.

7. Engines should be drafted, if possible, to burn one grade of fuel, and a reasonable effort should be made to keep the grade of fuel on the division to which the engine is assigned. Draft appliances should have a standard setting for each class of engines and the grade of fuel to be used. It altogether too frequently happens that if a certain crew has steam troubles that changes are made in draft

appliances when there is nothing wrong except improper firing or improper operation of engine. Then again, changes are made in draft appliances to overcome such defects as leaky steam pipes, leaky exhaust stands, leaky units or air leaks into smoke-arch around smoke-arch door steam pipe joints where they pass through smoke-arch shell, etc.

8. Engines should at all times be operated with the idea of doing the work assigned to such engine and such operation should be as economical as is consistent with the work to be performed. A watchful and consistent engineer can accomplish much that will aid in fuel economy if he will at all times note any defects that would increase the consumption of fuel and have necessary repairs made on arrival at the terminal. Conditions that cause the engine to burn an excessive amount of fuel should always be given due consideration by both engineer and fireman and the foreman in charge at the terminal where such work is to be done.

Steam leaks at steam pipe joints, exhaust stands, header and unit connections, pop and whistle valves, piston rods and valve stems or any leak that will permit steam to pass out to the atmosphere without first aiding in the "pull at the drawbar" should at all times be kept at a minimum.

10. Valves, valve at rings and cylinder packing blowing are liberal contributors to excessive fuel use. Superheater and small tubes partially or wholly stopped up with ashes or clinkers are responsible for cutting off a great deal of heating surface and changing the effect of the draft on the fire.

11. Permitting excessive brake pipe leakage to exist on our trains causes air compressors to work hard and continuously using far in excess of the amount of steam they should use to maintain the desired pressure and all of this means more fuel. If our brake pipes were kept reasonably tight and such leakage reduced to a reasonable minimum, it would aid materially in economy of fuel.

12. The valves and cylinders of the locomotive should be kept well lubricated to avoid operating the engine against dry valve seats and cylinder walls.

The discussion that followed the committee's report was participated in by a number of members and it might be justly said that there was not any part of the locomotive left untouched that had any bearing on the question of fuel consumption. The earnestness with which the matter was discussed showed how thoroughly the members had considered the subject, and while there was not much that was new brought forward, there was an emphasis placed on the greater need of earnestness in economy in the use of fuel that spoke well for the future in railway service.

A special message expressing loyalty and a desire to render every possible assistance in promoting the full effectiveness of locomotive service was transmitted to the President of the United States, the Premier of Canada, and to the Director General of Railroads.

On Thursday, September 12, Mr. E. F. Wentworth, Chairman of the Committee on the subject of

CO-OPERATION BETWEEN THE TRAVELING ENGINEERS AND THE GENERAL AIR BRAKE INSPECTOR

presented a very comprehensive report in the course of which it was stated that the air brake manufacturers, to meet the more exacting conditions imposed on the air brakes, have made every effort to improve and change the equipment to meet the requirements. Although the improvement in brake equipment for both locomotives and cars has been rapid, it is doubtful if it has kept pace with the requirements, and a higher state of maintenance than was required a few years ago is now necessary if we expect to get the desired results.

As changes in road conditions take place, the traveling engineer, on account of his being in close touch with the men handling equipment and with operating instructions regarding increase in tonnage and length of train, also placing of power, is in a position to either notice or have his attention called to irregularities that interfere with good train handling; and as a rule men handling equipment give their opinions freely as to cause and remedy for troubles, to the traveling engineer. Although many of these opinions finally prove to be worthless, they are all worthy of consideration until the real cause of trouble is found, and close co-operation on the part of the traveling engineer and general air brake inspector in the analysis of suggestions offered by men handling equipment and of their own observation regarding the cause of and the best methods of overcoming trouble, will result in intelligent conclusions as to cause and prompt remedies being applied.

We believe that practically all air brake troubles that cause delay and damage to equipment are avoidable; also, that they are due either to a poor condition of maintenance or improper handling. Where improper handling is the real cause, a continuation of the trouble is almost inexcusable, as most men handling equipment are glad to handle it properly if the right way is pointed out to them, and as the traveling engineer and general air brake inspector are looked to by the men for proper instruction, it follows that close co-operation regarding best methods of handling is absolutely necessary on the part of the traveling engineer and general air brake inspector.

Where such co-operation does not exist it will be generally found that the men have little confidence in instructions given by either, and they will handle the equipment according to their individual ideas, which, as a rule, vary from the best methods, to those that are to blame for damage.

The traveling engineer, as a rule, comes in contact with real troubles that are due to changes in conditions, which require changes in handling, before such troubles come to the attention of the general air brake inspector; and as a rule improvements and changes in equipment first come to the attention of the general air brake inspector. It therefore follows that frequent exchanges of opinions on the part of these men will result in best methods being put in practice and delay and damage being kept down to a minimum.

It is of the greatest importance that the air brake equipment on the locomotive be kept up to a high standard of maintenance, and if roundhouse forces are properly organized the equipment will be thoroughly inspected by competent men, and proper repairs made as soon after engines arrive as possible. However, it is a fact that many of the air brake troubles blamed to train equipment are due to a poor condition of maintenance of locomotive equipment, and it is also a fact that too many locomotives are allowed to make trip after trip with main reservoirs improperly drained, excessive pipe leakage, improper air pump lubrication, excessive pressure variations due to feed valve and governor defects, brake valves and distributing valves, etc.

Brake pipe leakage is one of the most prolific causes of air brake troubles on the road, and although all of us very often hear men handling equipment complain of brake pipe leakage, it is seldom that we can find a man who has any idea of how many pounds per minute brake pipe leakage exists on the train he is handling. It is therefore our opinion that men handling trains should be educated to understand the condition of brake pipe, and when necessary to make report, a clear statement of the number of pounds per minute leakage should be made, instead of the usual report of "too much brake pipe leakage." Co-operation between the traveling engineer and general air brake inspector would result in a thorough knowledge of the actual brake pipe leakage conditions, and a thorough knowledge of such conditions in most cases would result in improvement.

It is probable that brake cylinder leakage is responsible for brake inefficiency more often than any other part of the equipment, and it is also probable that responsibility for such inefficiency is seldom traced to the cylinder unless leakage becomes excessive to the extent of practically making the brake inoperative. It is therefore apparent that brake cylinder maintenance should receive more attention than it does, and co-operation between the traveling engineer and general air brake in-

spector along this line should result in a more thorough knowledge of the actual conditions of brake cylinders, and a system of brake cylinder maintenance being adopted that would insure work being properly done at the time of cleaning, and proper material being used.

The use of inferior low-cost material in air brake repairs is responsible for more or less air brake inefficiency, and under the present cost of labor there is no doubt that the use of such material is much more expensive than the use of the best material, even at a higher price. While the traveling engineers and general air brake inspectors do not as a rule have much to say regarding the purchase of material, we believe that their co-operation in keeping the attention of higher officials on the quality of material being used, would in many instances, result in the best material being furnished, which in most instances would result in more lasting repairs being made which means a higher efficiency and lower total cost of maintenance.

The suggestions of the committees were generally approved, and in regard to the duties of a traveling engineer, while they are already numerous, it was held by many that the traveling engineer should be as thoroughly conversant with air brake manipulation as is the air brake instructor himself, it being the duties of the road foreman to instruct his men in the operation of the locomotive which is construed to comprise the workings of the air brake equipment. It was also maintained that no traveling engineer should require of others the performance of duties in any manner which he himself is not capable of demonstrating. It is expected, however, that the men are especially expert in their own particular lines, and should be referred to in intricate matters touching those lines. All that is needed is a complete and harmonious spirit of universal co-operation.

The next subject to be reported on was that of

LOCOMOTIVE CABS AND CAB FITTINGS

Mr. J. H. Desalis, chairman of the committee presented the report which covered the subject with a degree of fulness which would be difficult to surpass. After recommending heavier material for the corner posts, as well as uprights and flooring of the cab in order to insure less vibration, the report proceeded to recommend that the front of the cab should be designed with a view of placing the front windows as close as is consistent to the engine crews usual and proper position in the cab. This is to provide a broader view for the crew. The side windows provided for locomotive cabs are as a general rule of the sliding type, and a sash should be constructed in such a manner as to provide for small panes of glass, for the reason that the portion of frame between window panes forms a brace lessening the liability of breakage. Ventilators should be provided and so constructed as to exclude cinders. Gutters on sides of cab should be located immediately over the windows in a way that will afford all the protection possible to the engine crew.

Regarding injectors the committee were of opinion that better provisions could be made for the securing of the injector to the boiler. It was suggested that instead of casting the body of the injector so that it is held in place by frail studs that it be provided with a bolting flange similar in a way to the bolting flange on an air pump with a bed plate on the boiler to secure it firmly in place. This would reduce the vibration and eliminate the strain on pipe connections and injector tubes, thus decreasing wear and liability of failure while there is no standard location for injectors, good arguments can be advanced for locating the injector on either the inside or outside of the cab. This is a proposition that is governor by local conditions, such as type and size of engine. Where injectors are located outsire of the cab, suitable provision should be made to apply and secure the operating rods in such a manner as to eliminate lost motion. Many mistakes have been made by not providing substantial rods equipped with durable joints and suitable brackets to withhold the rod from turning and thereby change the capacity at times when it should remain constant. Regardless of other details on location of injectors, the operating handles should be located conveniently within reach of the engine crew, so that injectors may be started, shut off or regulated from the usual and proper position of the engine crew in the cab.

Special attentioin is invited to the necessity of having operating rods connected to all valves on the injector for the reason that this has not always been considered a necessity on overflows and water valves. We feel that there is no question but that the "bull's eye" type of lubricator is most desirable, but this, like the injector, deserves better attention with respect to the manner in which it is secured. To care for this in a durable manner, provision should be made for at least two-bolt connections on the lubricator and a bracket on the boiler of ample strength to care for vibration. Lubricators should be located so that during daylight hours sight feeds would be visible and a suitable light provided to care for this at night.

While the throttle valve is covered by rules of the Interstate Commerce Commission as to the manner in which it should be maintained, it is the opinion of the committee that it is desirable to have a throttle lever provided that can be readily handled by the man located in a position where he can at the same time have his head outside of the window in order to observe signals from either front or rear of engine. It has been in some places the practice to have the handle on the throttle lever too close to the boiler head when in shut-off position. Where a power reverse gear is used an indicator should be provided to indicate the position of the valve gear, in order to provide against the engine moving in the direction opposite from that intended as may be the case where a low steam and air pressure exists. When air reverse gear is used, the steam connection globe valve should be provided within handy reach of the engineman in the cab, so that the steam pressure may be readily turned on in case of air pressure failure.

In locating automatic and independent air brake valves in cabs, particular attention should be paid to locating them in such a manner as to provide ample clearance with the handles in any position so that they may be easily operated from the engineman's usual and proper position in the cab. The proper position when handling the brake valve should be a position that would enable the engineman to have clear vision both to front and rear of engine. It is also desirable on the part of the engineman and fireman to have the dial on gauges made so that it can be readily read or seen. The gauge hands should be of liberal size.

These two features are great assistants to both engineman and fireman, and are particularly a great benefit to the fireman whose duty requires him to read the indication shown him on the gauge immediately after looking into the incandescent light of the fire box. It is believed that if a vote could be taken a great majority of the enginemen and firemen would favor the enameled hands and dials for gauges.

ENGINE FAILURES, CAUSES AND REMEDIES

Mr. F. T. Roesch presented a report on the above subject, and in the course of which gave a definition of what constitutes an engine failure: All delays waiting for an engine at an initial terminal, except in cases where an engine must be turned and does not arrive in time to be despatched and cared for before leaving time; and all delays on account of engines breaking down, running hot, not steaming well, or having to reduce tonnage on account of defective engine, making a delay at a terminal, a meeting point, a junction connection, or delaying other traffic.

If an engine apparently fails on the line of road, it is charged as an engine failure, although the engine may be in perfect condition and the delay due entirely to other causes, such as mishandling on the part of the crew, either engineer or fireman, excessive tonnage, weather conditions, or any of a hundred possible causes, any of which may result in a poor engine performance and for which the engine or its condition is

least of all responsible. The true cause of the poor performance should be determined by a full investigation, which, however may not be possible immediately and, consequently, when determined several days may have elapsed before the cancellation of the charge is requested. This being the case, it appears to this committee, in justice to the mechanical department, it would be much more equitable were all doubtful cases simply shown as delays on the "morning report" and these delays then promptly investigated and where the failure is established it be so reported on a subsequent report, or else a monthly report compiled, showing all failures and delays.

Any criticism to be of value must be constructive; therefore, as a first step toward the elimination of engine failures, we would recommend a closer relationship between all departments of a railroad, "get-together" meeting about once a month where engine and train performance can be freely discussed and wrong practices corrected.

We would also recommend that the mechanical department be kept advised as far ahead as possible of any power requirements, so that fitting preparation can be made; where no such system obtains the roundhouse foreman will sometimes take a chance when pressed for power and let an engine go on the assumption that perhaps it can make just one more trip.

New devices are continually being applied and too often men are expected to familiarize themselves with these with no other instructions than that contained in descriptive pamphlets. One ounce of ocular demonstration is worth a pound of reading in such cases, and we feel that enginemen should not be condemned for lack of knowledge where no adequate means for instruction obtains. We feel that all new methods or devices should be thoroughly explained and demonstrated to the men whose duty it is to operate or work with them, before we can place ourselves in a position to critricise. Every roundhouse where repairs are made can be fitted up with instruction rooms, containing charts or models, or both, and certain hours or days can be set when instruction will be given. Then if the men do not avail themselves of the opportunities offered action can be taken in case of man failure.

ELECTION OF OFFICERS

The following officers and members of executive committee for the ensuing year were elected:

President, H. F. Henson, Norfolk & Western; first vice-president, G. A. Kell, Grand Trunk; second vice-president, W. E. Preston, Southern; third vice-president, L. R. Pyle, Railroad Administration; fourth vice-president, E. Hartenstein, Chicago & Alton; fifth vice-president, J. H. DeSalis, New York Central; treasurer, David Meadows, Michigan Central; secretary, W. O. Thompson, New York Central; executive committee—W. H. Corbett, Michigan Central; S. V. Sproul, Philadelphia, Baltimore & Washington; T. F. Howley, Erie, and F. Kerby, Baltimore & Ohio.

Chicago was again selected as the meeting place of the next convention, and in closing the session the Secretary reported that over 200 new members had been added to the roll, making the entire membership over 1,300.

BUY LIBERTY BONDS

Service and Civility.

The Director General of Railroads has enunciated the doctrine that at the present time all railroad employees in every grade are government officials, and therefore servants of the people. This may not at first sight appear to be a very weighty announcement, but it is much more than it seems, because in it is contained the essence of Democracy. Democracy, strictly considered, is not a "hail-fellow-well-met" attitude among citizens, nor is the easy, and often misplaced familiarity between persons of different stations, nor should there be any cringing servility between man and man, but there most assuredly should exist a dignified, self-reliant, respect for one's self, which is reluctant to encroach upon the rights of others, or seem to infringe upon another's place.

Democracy, properly considered is a political condition, in which the people are the ruling power over themselves, and they carry on the work of governing, which is a department of national life, by means of properly chosen experts and functionaries, elected for that purpose. Now as the real source of power is the people, the consideration and respect which is claimed with ruthless insistence by the autocrat, really belongs to the people, and in thus emphasizing the position of all railway employees to the public, the Director General has put the whole matter in its true light.

Mr. Geo. A. Cullen, chairman of the U. S. Railroad Administration Committee, seems to have admirably caught the underlying principle, contained in the words and wishes of his chief. Mr. Cullen, in addressing the managers, agents and employees of the New York ticket offices, among other remarks, said: There are two things which neither the Director General with his liberal policy nor the Committee with its utmost ingenuity can possibly supply and which rest wholly with the men who are charged with the work. The first of these is the spirit of service. We live in a new day when men and women are living more for ideals than ever before. There is here an opportunity for service to the public almost unmatched in commercial life. Our employees meet each day more people seeking important, accurate and vital information than, I believe, any other organization in the city. One can respond in a careless and perfuntory way, doling out half-facts and guesses, or one can painstakingly ascertain what the inquirers want to know and then give clear, explicit and understandable answers. One can give transportation and accommodations in a grudging and indifferent manner or do this with carefulness and alacrity and with consequent satisfaction.

The other feature is wholly dependent on the attitude of the staff, and for want of a better name we may call it the spirit of civility. Civility is not a mask to be put on or a smile or an external assumption of politeness. To be of any lasting value in the day's work, or the year's work, it must come from an honest and whole-hearted desire to put oneself in another's place. It must come from thinking how each employee himself would like to be treated if he were asking information or trying to secure transportation. In a word it is the constant practical application of the Golden Rule in our work and it is more essential than all the so-called rules and regulations that the Committee can possibly set down.

After all the Golden Rule is the foundation of the structure of true Democracy, but if the attempt is at any time made, to build a house upon the sands, and cover it with a coat of varnish to resemble a true civility of heart, that house on the sand will crumble when the first rain or tempest may shake it, and great will be the fall thereof.

BUY LIBERTY BONDS

Bureau to Stimulate Production.

The organization of the Production Bureau of the United States Fuel Administration, headed by Mr. James B. Neale, who had been acting as anthracite adviser to the Administrator, Mr. Garfield, was announced in June of this year. This bureau took over, for expansion, the numerous activities directed toward increasing the volume of coal mined and coke produced, and an intensive campaign to stimulate production was inaugurated. The situation then was that, while a weekly average of about 11,700,000 tons of bituminous coal had been produced during May, the coal requirements of the war industries had increased to a point where, to avoid shortage, the weekly average must be raised about 1,000,000 tons for the rest of the current coal year.

BUY LIBERTY BONDS

From present indications there will be no great difficulty in meeting the increased demand, as the war spirit seems to animate the miners in a most praiseworthy degree.

General Construction and Maintenance of Superheater Units

In the early days of the application of the devices used in superheating steam in locomotives it will be remembered that considerable difficulty was experienced in retaining the absolute freedom from leakage in the joints of the pipes which is so essential in securing the full benefit or increase in power that may be derived from the use of superheated steam in the modern high-powered locomotive. This was not all, as rapid deterioration of the ends of the superheater pipes that projected nearest to the fire-box was another detriment. Both defects have now been completely overcome, the former by the introduction of tools of a light and portable kind that readily form conical and spherical bearings that are not only reliable when put in place but remain so in spite of the constant changes of temperature arising from the situation. The latter difficulty has been overcome by the abolition of the early U-shaped unions into which the superheater tubes were screwed, and substituting return bends integral with the pipes of the unit, and from the same tubing with which the unit is constructed. This was only made possible by the use of improved material, the tubes now used being of low carbon, cold drawn, seamless steel. This bending, and welding and thickening of the projecting end of the superheater tube is a machine forging job throughout. No acetylene or electric welding is used in this process, and yet the degree of skill in forming the part is such that the bend is not reduced in cross-section, and at the same time the increase in size of the return bend as compared with that of the pipe is so slight that practically no additional obstruction is presented to the flow of gases. The steps in the manufacture and the comparative area in the bend of the tubes, as well as the increase in the bend of the tubing is shown in our illustration, Fig. 1.

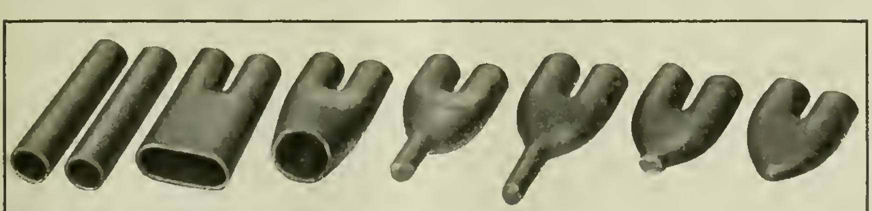


FIG. 1.—FORGED RETURN BEND, SHOWING THE STEPS IN THE MANUFACTURING PROCESS.

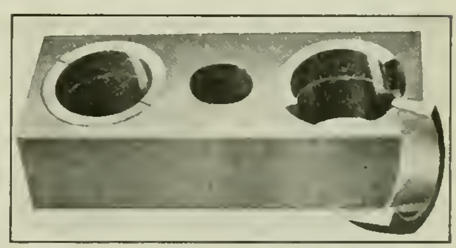


FIG. 3.—EMERGENCY CLAMP FOR UNITS.

Coming to the smoke-box end of the tubes, it may be stated briefly that the ball ends on the unit pipes are formed by upsetting, a three-operation die being used to prevent folding or creasing of the material, after which the ball ends are annealed and accurately turned in a turret lathe so that the finished surfaces, one forming a seat in the header and the other resting in the clamp, are true parts of the surface of a sphere 2⅛ ins. in diameter. The ball joints are carefully

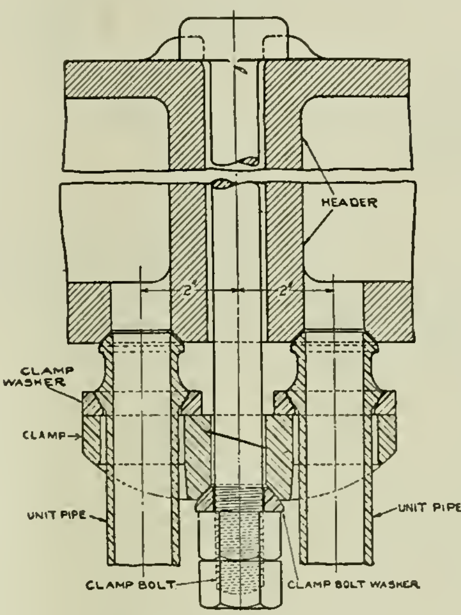


FIG. 2.—UNIT PIPE ENDS SHOWING CONNECTIONS TO THE HEADER

ground to this contour, the correctness of the grinding being insured by spotting in gauges that are hardened and ground to the precise segment of a circle. Fig. 2 shows the improved method of connecting the tubes to the header by means of a clamp and a threaded bolt, with nuts passing through the header, and holding two of the tubes in place. In case of damage to the clamp, an emergency clamp with holes large enough to allow the expanded end of the tube to pass through is furnished, the enlarged opening being filled by detachable washers. The clamps and washers, which with the unit bolts, hold the units in place, are are made of steel.

When the emergency clamp is used, an illustration of which is shown in Fig. 3. it is necessary that the old clamps be removed from the unit to prevent their wearing holes in the pipes, the old clamps being readily removable by the application of a cold chisel. The washer, it will be observed, is applied in a manner similar to that used in applying the gland for piston rod packing and piston rods having enlarged ends; that is, the split ring on the inside of the washer is removed and the solid ring slipped over the solid end of the unit.

For obtaining the final line bearing on both the unit end and the header, the most satisfactory method is the soft-metal grinding process. This process is both simple and cheap. A grinding cup of lead or hard babbitt metal is used for the unit end and a ball 2⅛ ins. in diameter, and of the same metal, for the seat in the header. These are used with powdered carborundum to obtain the line bearing, and when the cups and balls commence to lose their contour they can be melted and used over again. The mould for forming the cups and spheres is shown in Fig. 4. It consists of three parts—the base in which the cup grinder is cast, the base in which the spherical grinder is cast, and the top part of the mould which may be used with either base. A chuck is provided which will hold either the cup or the spherical grinder, the chuck having a shank suitable for use in an air motor. The use of these moulds renders practical the production, at a nominal cost, of grinding forms which are accurate in contour, by all terminals regardless of their mechanical equipment. There is practically no waste of material as the material can be used repeatedly.

In conclusion, it may be stated, being such a highly developed product, the superheater will stand a great deal of abuse without failing; but, as clearly brought out in what has preceded, the abuse of the superheater or the neglect or carelessness of enginemen or shopmen in operating the locomotive or in making repairs, will result in a falling off in the locomotive's capacity for doing its work. The means of keeping the units in good

working condition and obtaining the best results from the superheater are summed up briefly by the Locomotive Superheater Company as follows: Keep the tubes and flues clean. Keep the water in the boiler at such a level that it will not be carried over into the superheater. The superheater is built to superheat steam, not to evaporate water. Keep the damper, damper cylinder and rigging in good operative condition. Don't operate a locomotive with a damper tied open, nor permit one to be operated in this condition. Make sure that a good joint is obtained between the ball ends of the units and their seats in the header when repairs are being made, and keep the unit clamp bolts tight to prevent steam leaks. Apply the correct number of bands and supports and see that they are maintained.

The proper application of bands and supports is of the utmost importance. The pipes should be firmly held together at all times and unless the bands and supports are properly applied, the pipes will vibrate in the flue.

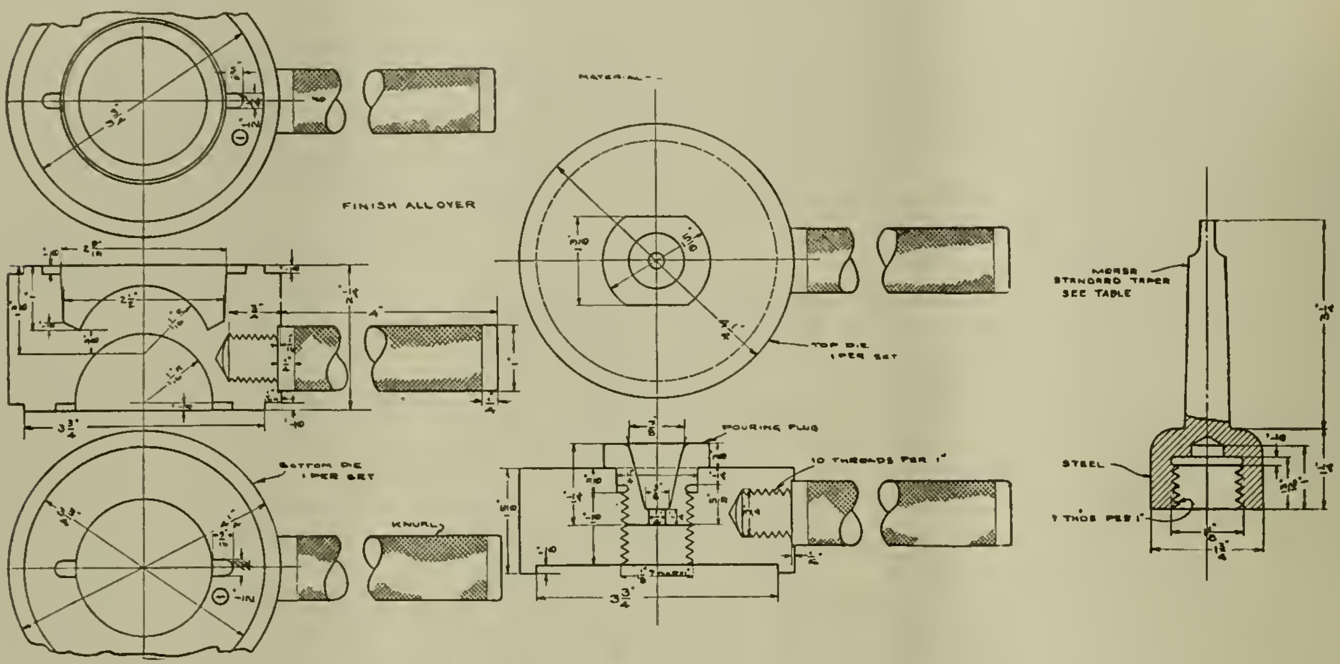


FIG. 4.—DETAILS OF MOULD AND HOLDER FOR SOFT METAL GRINDERS.

Annual Congress of the National Safety Council

The Seventh Annual Congress of the National Safety Council was held at St. Louis, Mo., last month. President David Van Schaack delivered the opening address and urged the delegates to a greater degree of earnestness in the work of safety in every industrial community. Mr. Hiram W. Belnap, manager, Safety Section, United States Railroad Administration, delivered an address before the Steam Railroad Section, which attracted wide attention. In the course of his address after pointing out the number of casualties that have occurred on American railroads during the last five years, Mr. Belnap stated that experience has demonstrated that the two elements that have the most important bearing upon both service and safety are the mechanical and physical, which involve safe machinery, track and structures, and the human element, which involves the entire personnel from the highest officer to the humblest employee. The mechanical element presents much the easier problem to solve, and it has already reached a high stage of perfection as is evidenced by the improved safety devices of almost every character that have been and are being constantly installed and applied upon every railroad in this country. From the great advancement that has been made during the last decade in the construction of tracks, bridges, locomotives and cars, and in the development and installation of improved signalling and other safety devices, one would naturally think that the number of accidents should be materially reduced. But such is not the case.

A study of these statistics clearly establishes the fact that the majority of accidents on our railroads, particularly to employees, are of a character that the most improved of mechanical devices will not prevent, and it is evident that the control and training of the human element is the great problem of the future. It is this problem to which the student of accident prevention must devote the greater part of his energies, if effective results in providing greater safety upon our railroads are to be accomplished.

It has often been stated that the accidents which swell the total are caused by the negligence of the injured employee. A general assumption of that nature is absolutely unwarranted. Men cannot properly be charged with willful negligence in case of injury until it is clearly established that proper instruction and supervision have in each instance been given to the jured employee, and Mr. Belnap thinks that when a careful study is made of each accident, it will be found in thousands of cases that this very lack of instruction and supervision has had an important, if not a controlling influence in the occurence of the accident.

Regardless of the fact that the men employed on the railroad are of an exceptionally high intellectual character, it is not proper to start them at work in this hazardous vocation without knowing in advance that they are carefully instructed as to the hazard of employment, and that they are competent and fully understand the duties they must perform. While frequently thoughtlessness, carelessness or even negligence is given as the cause of accidents, in many cases these are only excuses; the real, underlying causes being unsafe conditions and failure to instruct and constantly educate employees to the hazards of the position occupied. Continuing he said,

"Nothwithstanding the old saying, Accidents are bound to happen, accidents are

not inevitable. Most of them can be avoided by proper education, supervision and care, and through well organized, efficiently-handled safety committees a great deal can and will be accomplished. How best to do this is our problem."

During the last five or six years safety work on many lines of railroads has been carried on by employing different methods. Very few railroads handled this work alike, they thus effect many different results. Some reduced accidents, while others, even though carrying on a so-called "Systematic Safety Campaign," reflected an increase in casualties. Others kept no record of their safety work and could not tell whether they had accomplished beneficial results.

Immediately upon the creation of the Safety Section, a questionnaire was sent out to all Class 1 railroads, calling for information regarding the different kinds of safety organizations, their relative efficiency and the scope of their activities. From the replies received, it became apparent that to a large degree there was no uniform or well defined method in vogue, and with the exception of a limited number of roads, Safety work was supervised by no particular offcer, the result being that "What was everybody's business was nobody's business." On some railroads, after a trial, Safety work was subordinated to something "more important."

"Mr. Belnap also said for the purpose of standardizing this work as far as possible and practicable to do, under date of May 27, Circular No. 5 was issued, directing that each railroad under Federal control organize a General or Central Safety Committee, as well as safety committees on each division and in the principal shops and terminals, these latter committees to be composed of both officers and employees, the Superintendent of the Division to be Chairman of the Division Committee and the ranking officer in each shop or terminal to be Chairman of these committees."

"Proper means should be provided by which safety committeemen and employees in general can readily make suggestions and recommendations to the various safety committees. A postal card form can be used with advantage. A supply of these cards or other forms used should also be distributed to safety committeemen and others attending safety committee meetings, and every effort made to encourage their frequent use. If a thing is worth doing, it is worth doing well, and as the prime purpose of the work of the Safety Section is to bring about a substantial reduction of casualties, every possible effort must be made to bring about the desired results."

"It has been said that when an accident occurs, there is either something wrong with the machinery, the method, or the man. If this be true, and results in accident reduction are not forthcoming, the Safety Section will endeavor to find out the reason. This necessarily means that upon the supervising talent on the railroads will rest the burden of educating men in the principles of safety. When all officers and all employees finally realize that the Government is in earnest about this work and that it is just as much the duty of a supervising officer to supervise for safety as it is to get the cars out of the yard or trains over the road, I believe that we will have reached the high attainments expected in this work. To gain this, it is imperative that all shall give hearty co-operation, and push with all energy."

Mr. Belnap dwelt fully on the chief points of the new plan, laying particular emphasis on the need that all officers in executive positions shall give safety work their active co-operation; that it should be regarded as of the same importance as other branches of railroad work; that the fundamental principles of safety shall be wisely and energetically instilled into the minds of the men who do the actual work of operating the railroads, and that proper observance of the requirements of safety is a work of the men, by the men, and for the men.

In conclusion, Mr. Belnap stated that it had been an inspiration to note the enthusiastic manner in which the employees in all classes of the railroad service have taken hold of this work. Practically every employee's labor organization has already endorsed the Safety Section's work. Even now in many of their lodges a certain specific amount of time is devoted at each meeting to the subject of Safety and Accident Prevention. In some organizations it has been arranged that this be a regular part of their order of business. The hope was expressed that this practice will soon be adopted by every lodge in every organization upon every railroad in this country. When this is done, and when Safety Committees actively and efficiently perform their functions, we expect that we are going to have a material and substantial reduction in accidents. "If we can get men to talk Safety, they will begin to think Safety; and when they think Safety they are always going to be on the lookout for unsafe conditions, which can and should be corrected, as well as the unsafe practices followed by themselves and their fellow employees, and which must be discontinued. These are the things, above all else, that are going to make the Safety work successful on all railroads, and which can and will be brought about."

Peat.

The use of peat as fuel is increasing and might be much more increased. The public could be educated to use the stuff as a substitute for coal.

Work of the United States Railroad Administration.

The report of the Director General of Railroads, issued early in September, is of interest, in presenting details of what has been accomplished during the period in which the railroads have been under governmental control, as well as indicating what may be expected in the future. In regard to mileage and capitalization, it appears that on December 31, 1916, the total steam railway mileage in operation in the United States (all tracks) was 397,014 miles. This mileage was owned or controlled by 2,905 companies, employing some 1,700,814 persons. They had outstanding $10,875,206,565 of bonds and $8,755,403,517 of stock (par value).

The inland waterways system includes some 57 canals, 3,057 miles in length, some of which were owned or controlled by the railroads, and many thousand miles of navigable rivers, lakes, bays, sounds, inlets, traversed by innumerable craft.

Of the 2,905 railway companies 185 operated major systems, each of which had an annual operating revenue of $1,000,000 or more; 221 were switching and terminal companies; 1,434 were "plant facility" roads, constructed primarily for the purpose of serving some particular factory or industry; and 765 were what have come to be described as "short line" railways, dependent upon one or more of the larger systems for through connections.

This briefly describes the plexus of transportation facilities which came under Federal control January 1, 1918, or shortly thereafter. Some of the "short lines" and "plant facility" corporations have since been relinquished as not essential to the purposes in view, but every effort has been and will be made to deal equitably with the relinquished properties. To administer and operate this system the United States Railroad Administration, with headquarters at Washington, was promptly organized.

The reorganization of the operating force has been made without any impairment of efficiency and with a reduction in the number of officers required and in the aggregate of the salaries paid them and chargeable to operating expenses.

This shows that under private control of the railroads 2,325 officers drawing salaries of $5,000 a year or over were employed, with aggregate salaries of $21,320,187. Under Government control, 1,925 officials (a reduction of 400) are doing the same work, and the aggregate of their salaries is $16,705,298—a saving of $4,614,889 per annum. This total includes the officers of the various regional districts as well as those of the central administration in Washington, except the Director General himself, who receives no salary.

Advance in wages has been made ranging from 43 per cent in the case of employes drawing the lowest monthly wage

to nothing in the case of those receiving as much as $250 a month; and an order has been issued recognizing that justice demanded the adoption of the basic eight-hour day in railroad service. This important and far-reaching step embraces all employes in the mechanical crafts, with time and a half for overtime.

To provide for the increase in wages allowed, the higher prices that must be paid for all supplies, and the rising costs of operation generally, an average advance of 25 per cent in freight rates has been ordered and passenger rates have been raised to a minimum of 3 cents per mile where they were previously lower. In the districts where more than 3 cents a mile has been charged fares have not been changed. Commutation fares have been advanced 10 per cent.

Referring to the standardization of freight cars and locomotives, the report states that it has long been admitted that the standardization of the engines and freight cars in use on the American railroads was highly desirable, but not until governmental control became a fact has it been possible to secure an effective agreement as to which types of cars and engines should be adopted. It is said that 2,023 different styles of freight cars and almost as many different descriptions of locomotives were included in the equipment of American railroads prior to the war. The facts are not known, but nearly every important railroad had its own specifications for cars and engines. None of these was identical, and they were generally changed in some detail when new orders were placed. There were box cars of both steel and wood, gondola cars, flat cars, hopper cars, refrigerator cars, tank cars, automobile cars, furniture cars, cattle cars, and many other sorts of cars suited to the different varieties of traffic. The lack of standardization increased the difficulties of repair when these cars were off the lines of the roads which owned them. Parts were not interchangeable and often had to be telegraphed for.

In a general way the same thing was true of the locomotives in use. Complete standardization will of course be impossible until the rolling stock and engines now in use shall have been entirely replaced by standardized types. Progress has, however, been made. Some 12 standard types for freight cars have thus far been agreed upon, and it has also been decided that hereafter only six types of locomotives of two weights each shall be purchased. The parts of these various types of locomotives and freight cars will be interchangeable. Their construction will be uniform and when repairs are needed they can be made with the greatest possible promptitude.

One hundred thousand freight cars of the agreed upon types have been ordered, and it is expected that the manufacturers can commence delivering them early in September. One thousand four hundred and thirty locomotives of the new type have also been ordered, in addition to about 2,100 that had been contracted for by the railroads prior to January 1, 1918. Of the total of about 3,600 locomotives, some 1,185 had been delivered up to August 1. The equipment of all the railways December 31, 1917, included about 2,400,000 freight cars and 64,750 engines. The ratio which the newly ordered cars and engines bear to the total is not as large as is to be desired, and other orders will be placed as rapidly as the manufacturers can accept them. Just at present, however, the War Department is taking a large number of the new engines and cars for use on our railroads in France, and these with the orders placed by the Railroad Administration will more than absorb the entire manufacturing capacity of the equipment and locomotive plants in the immediate future.

The material and supplies annually purchased by the railroads have hitherto cost between $1,500,000,000 and $2,000,000,000 a year. When the carriers were in competition for traffic they were also in competition for the supplies required. This competition has been for the most part eliminated and a substantial saving has been effected as a result of the supervision over all purchases exercised by the director of the division in charge of them. He is aided by an advisory committee of three composed of the General Purchasing Agents of the three leading divisions of the Federal Railroad System and acts through Regional Purchasing Committees, with headquarters in New York, Chicago and Atlanta, to whom the larger part of the buying that is done for account of the railroads is intrusted. It is planned shortly to enlarge the Advisory Committee by including a representative from each regional district.

BUY LIBERTY BONDS

Boiler Horsepower.

As we have before now pointed out, the "horsepower" of a boiler is not a definite or accurate thing. Years ago Watt conceived the unit of horse power as the average measured performance of a London dray horse. The time element enters into this conception, and therefore makes it the rate at which work is done. It is the lifting of 33,000 lbs. one foot high in a minute of time. Any change in one of the figures, requires a change in another. Thus one horsepower may be 550 lbs. continuously lifted against the force of gravity, for 60 minutes or one hour.

The measure of the capacity of a boiler is the amount of "boiler horsepower" developed, a horsepower being defined as the evaporation of 34.5 lbs. of water per hour from and at 212 degs. Fahr. The term horsepower is not generally used, however, in connection with boilers of locomotives, and such boilers are designed to suit the engines and are rated by the extent of grate and heating surface only.

The unit of evaporation—i. e., the evaporation of 34.5 lbs. of water per hour from and at 212 degs. Fahr. is an arbitrary unit originally adopted in 1876 because it was considered to be the steam requirement per indicated horsepower of an average engine. It means the evaporation of 34.5 lbs. of water per hour from a feed water temperature of 212 degs. Fahr. to steam at the same temperature.

Unless a particular boiler is tested for the actual amount of evaporation per hour from and at 212 degs. the nearest approximation we can make to its capacity is done by multiplying the total heating surface in square feet by 3 and dividing the result by 34.5 to reduce to result to "boiler horsepower" units.

$$\text{Boiler horsepower} = \frac{\text{Square feet heating surface} \times 3}{34.5}$$

The factor 3 in the numerator of this expression is an average value for the number of pounds of water evaporated from and at 212 degs. per square foot of heating surface.

For the measurement of heating surface the usual rule is to consider as heating surface all the surfaces surrounded by water on one side and by flame or heated gases on the other, using the external instead of internal diameter of tubes for greater convenience in calculation. This method is somewhat inaccurate, for the true heating surface of a tube is the side exposed to the hot gases —i. e., the inner surface in fire tube and the outer surface in watertube boilers.

With such a calculation for horsepower without test data, refinement of accuracy is unwarranted. A rough rule for finding the heating surface of horizontal tubular boilers, as given in Kent's "Mechanical Engineer's Handbook," is as follows: Take the dimensions in inches. Multiply two-thirds of the circumference of the shell by its length; multiply the sum of the circumference of all the tubes by their common length; and to the sum of these products add two-thirds of the area of both tube sheets; from this sum subtract twice the combined area of all the tubes; divide the remainder by 144 to obtain the result in square feet.

BUY LIBERTY BONDS

At Home and Abroad

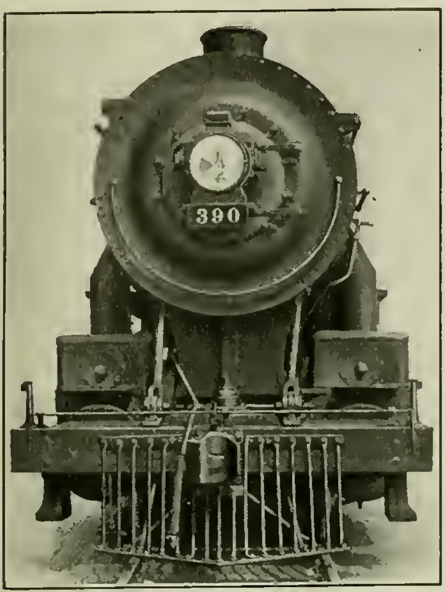
Our soldiers in France are gloriously doing their part toward victory; the Liberty Loan subscription must show them that the people at home are doing theirs.

BUY LIBERTY BONDS

The American Flexible Bolt Company of Pittsburgh has opened a branch office at Cleveland, Ohio, in charge of L. W. Widmeier, who was formerly assistant general sales manager at their New York office.

Making Good Engines Better on the Delaware, Lackawanna & Western

The Delaware, Lackawanna & Western have lately experienced a good deal of satisfaction from what is often called "Making Old Power, New", on a considerable number of their engines. The engines have had superheaters applied to them and a substantial economy has been



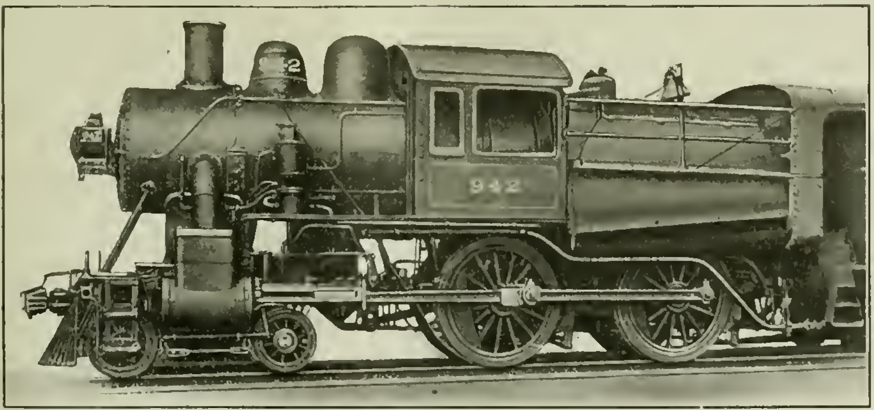
FRONT OF D., L. & W. ENGINE WITH OLD CYLINDERS AND NEW UNIVERSAL STEAM CHESTS AND VALVES.

the result. In order to put in piston valves so as to get the best results from superheating, Mr. H. C. Manchester, the superintendent of motive power and equipment restored to the use of the valves and steam chests made by the Franklin Railway Supply Co., Inc. The economy of between 17 and 25 per cent, which is said to have resulted, came practically all from the superheater, but the use of this make of piston valve and steam chest, enabled the whole thing to be put in operation at a very much reduced cost. This is the "*raison d'etre*" of the universal valve and steam chest.

The D. L. & W. now have 50 engines of this type with superheaters and piston valves, 25 more are to be so fitted as they pass through the shop, and the still further use of the appliance it to be made to many more engines. This road was formerly entirely equipped with ordinary slide valves. Although exhaustive tests have not been made, a practical demonstration of efficiency has been given by the engines themselves, and it has been found that ordinary engines that were loaded beyond their capacity, as saturated steam users; after the superheater and Universal valve chest treatment had been applied, were able to handle one more steel car on the same schedule, and easily make time since their conversion.

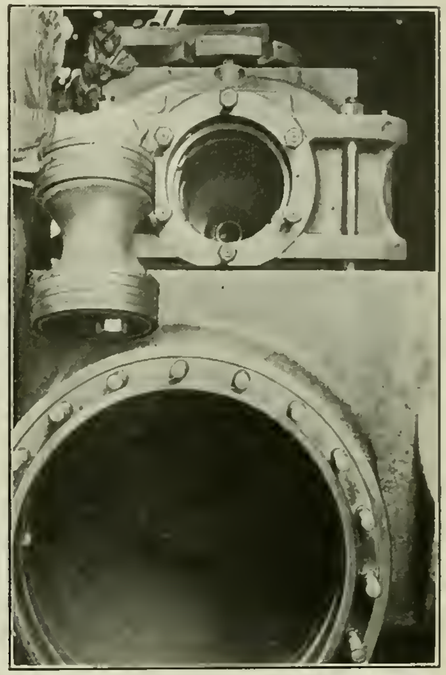
Large consolidation type engines, which as saturated steam users, requiring two firemen, are now superheated and have Universal valves and steamchests, and only require one fireman to do the work. The firemen on the road prefer to fire this class of engine, so equipped, to the smaller consolidation, or 2-8-0 engines which have 15,000 lbs., less tractive power. No trouble is experienced with lubrication, the renewed engines run on the same quantity of oil, as formerly, when they did less work. They are equipped with 3-feed lubricators, which is the same appliance they had when running on saturated steam, in the past.

Here is a three-fold improvement, viz: an extra car on an old established schedule, one fireman instead of two, and no alterations in the lubricating arrangement. This amounts to a practical demonstration given by the engine itself, that cannot be discounted. It spells advancement in the mechanic arts and affords a striking economy of coal, man power, and oil. These things are essential now-a-days.



"AMERICAN," OR 4-4-0 ENGINE ON THE D., L. & W. FITTED WITH SUPERHEATER AND "UNIVERSAL" STEAM CHESTS AND VALVES.

A typical example of making old engines new, may be had by considering a 22 x 26 ins., engine. In order to use



OLD CYLINDER WITH "UNIVERSAL" STEAM CHEST AND VALVE.

piston valves with superheated steam, new cylinders and steam chests and valves are ordinarily required. This necessitates not only the application of new cylinders and valves, but it requires an alteration of the ends of the frame fronts and new bolts, boltholes, etc. The weight of the whole outfit is practically 24,000 lbs. The weight of the Universal valves and chests is about 2,500 lbs. so that a saving of 21,500 lbs. is made on each conversion. This amount of metal is extremely hard to get at present, and the saving is worth more than it looks in figures.

An old culm-burner on the D. L. & W. pulling passenger, of the "American" or 4-4-0 type, in vogue long ago, has so far been made new, as to take an extra car on its train, where formerly it handled only wooden cars; and this extra car is steel, of about the same weight as the steel train which it now hauls. The practical value of the alterations made by Mr. Manchester are worth to the road, and to the country, a good deal more than is represented by the mere setting down of the figures representing the metal, the oil, and men concerned.

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Haustum Fortum, Haustum Longum, et Haustum Simul Omne.

The appeal for the Fourth Liberty Loan has been made by the Government. The dates fixed are from September 28 to October 19, 1918. This is a loan, as the others were, payable in full in a few years, and bearing interest at 4¼ per cent. per annum, during the intervening time. We did not begin this European struggle, it is the "Battle of Armageddon." We were ruthlessly attacked without reason, in the most dastardly way, murder and piracy took the place of war, and all largely because of our wealth, our position, and that we stood for the rights of man. We had made the theory of Democracy into a practicable scheme. We had made it work, and no greater affront can be offered to a misguided man or nation, however unwittingly it be done, than to make a success of what he or they abhor, and Autocracy is therefore at the death grapple with the rights of man. We well know that the men who are now doing our behest, our Government, have the same "will to conquer," that is felt by the man in the street. Our fighting men are taking their place along with the sorely-tried nations of Europe fighting in the same good cause, but we bring fresh with us the bulldog tenacity and the stubborness in fight of the great Anglo-Saxon race to which we belong. This nation cannot be conquered because it will never give up. This means to us a justifiable source of pride, not of boasting. The men who do the fighting for us need rifles, bullets, machine guns, cannon, food, clothing, boots, tobacco, and last, but not least, the bayonet. The words of the Psalmist may perhaps be taken as applicable, in a sense, to present-day warfare. "Thou shalt break them with a rod of iron; thou shalt dash them in pieces like a potter's vessel." The bayonet or "rod of iron" has always been a terrible weapon in Anglo-Saxon hands.

These things which the soldier needs cost money, and our Government, to carry out our will, in our war, asks for the means to do our bidding. The news from the front shows that day by day American forces, with the Allies, Great Britain, France and Italy, are steadily forging ahead. The Huns will never be asked to go out of Belgium and France, they will be driven out by force, and the victorious troops have even now their eyes on Berlin as the last "objective." We have bright days ahead, we have the courage and the certainty of almost fulfilled hope. But we have yet to overcome. We still must make a great sacrifice if we would triumph. The fourth Liberty Loan is one of the ways the non-military citizen can yet wield the rod of iron which shall break our foes. With the bright vision of victory before us we must yet struggle for the full and completed result. Victory is assuredly ours, but we must, as the heading of this article indicates, get together, and make a long pull, a strong pull, and a pull all together.

The necessity of looking at things as they are is upon us, it is imperative. We are sure to win, but not without effort. Let us make that effort strongly, as one man; and work, and lend money to the Government, and with our effort many blessings will come to us in due time a hundredfold. Events in Europe today are full of promise, and when the war is over we will, as Tennyson says, go forward, "In that new world, which is the old." Old because the same old world will hold the same old friendships, the same old delights of living, the same old duties to perform. The same old opportunities of serving fellow men, but new, gloriously new, in the abiding realization of Peace, with new thoughts and aspirations, and the dawning of the millenium years, where the ethics of Christ will grow, and in time become the commonplace rules of the wharf, the warehouse, the factory and the mart.

We see all this coming, with victory and with peace, but there is before us one great, strenuous effort, which will make it really ours, so that none may make us afraid. The hard work, the toilsome effort, the heavy sacrifice lie just ahead, and come just before the great milleneal rest. Shall we not be recreant to the high trust we have taken upon ourselves if we fail to support our Government at this time, and in our own war? A much greater than Henry V, calls upon us now, as we stand, like greyhounds in the slips, straining upon the start; when the sprit adjures us, "Once more into the breach, dear friends, once more."—The one supreme effort at hand has yet to be made; it must and shall be made.—A long pull, a strong pull, and a pull all together, and the great day is ours. Then the stained and battle-torn flags will be furled, in the long, happy, tranquil, halcyon days that are to be; but first, as Gibbon says, "A heart to resolve, a head to contrive, and a hand to execute."—Fides et Fortitudine.

BUY LIBERTY BONDS

Government Operation of Railways

It is only to be expected that in a free country the government of that country will be criticized, and the government of the United States is no exception to the rule. It also implies, however, that the accused party has an undoubted right to make reply. The repy to the strictures on the government operation of the railways, which appeared not long ago in a prominent daily in New York, has fallen to the lot of Mr. T. H. Price, the actuary to the U. S. Railroad Administration.

The complaints, when stated briefly, and the answers thereto make very instructive reading, and the replies contain facts the public ought to know. We commend the perusal of the government rejoinder to those (and they probably form the majority) who have only seen the adverse criticism and have not pursued the subject any further. It is claimed, for instance that under government operation, there has been a heavy advance in freight and passenger rates, to which the government makes the reply that the advance in the cost of transportation is less than the advance in wages and the price of almost every other commodity that society requires. Again it is said by way of criticism, the abolition of the through bill of lading for export freight and the cancellation of export and import rates, is bad.

In rebuttal of this, Mr. Price points out that through bills of lading for export, cannot be issued because the government has preempted the ocean room and there is no assurance that the goods can be forwarded upon arrival at the seaboard. A further stricture on government operation is the dismissal of solicitors who "took an interest in the handling of the traffic" and the consolidation of freight and ticket offices.

To which the government replies, very forcibly and with perfect truth, as every one knows, that as competition between the railroads no longer exists there is no occasion for competitive solicitors and ticket offices and that their abandonment

will save the railroads about $23,000,000 annually. A saving of this magnitude, cannot be overlooked or dismissed by a wave of the hand, and its full significance should sink into the mind of each reader.

True, it is monopoly, but think what such a monopoly means to the public. Let any one imagine where we would all be, if the postal facilities of the country were to be controlled by private enterprise, backed by the avowed purpose of securing gain. The post office department is the most complete monopoly in the world, yet few would seek to change it, and all are beneficiaries of its monopolistic working.

Again, the critics object, that the withdrawal of the credit previously allowed in the matter of freight charges which must now be paid before or upon the delivery of the goods unless the consignee gives a bond that will protect the government. The logical reply is, of course, that the government is not authorized to extend credit to consignees for the freight they owe when the goods are delivered, and that it cannot exceed its legal authority. A further allegation speaks of the difficulty of getting information regarding tariffs and rates. To which the answer is that a new and simplified classification and rate book has been prepared, and will be effective and available as soon as the shippers themselves approve it. Those concerned will see it, and agree to it before it is used. This is a fair and businesslike method of procedure. Another reproach leveled at the government operation contends that the discontinuance of the package car service between important jobbing and consuming sections is unwise. In reply it is said by those in authority that a continuance of the package car service would have involved a wasteful use of facilities that are needed for the winning of the war. Lastly, the government is reprobated by the same critic, for the withdrawal of a shipper's right to route his own freight as he may choose. The answer to this is practically self-evident, but it amounts to this, that if shippers were allowed to select the routes by which their freight would be carried, the efficiency and economy that are shown to have been secured by rerouting could not have been obtained. Caprice or self-interest would then hold against a species of sanctified commonsense.

The whole government policy amounts to the intensive use of existing equipment before other equipment (now on order) can be added to, and these additions are to come after the new war equipment now urgently needed in France have been supplied for the carrying on of the war. Government operation is not a delicate experiment, made under ideal conditions, for the purpose of proving government superiority to private operation. It is work done in the face of an emergency; a pressing, imperative demand. It is not made by a group of men in order to bolster up one set of views and to throw down another set. It is the conscientious attempt by those in office to do the best for the whole nation, under the abnormal, exacting, and paramount urge of a world, disorganized from without, by war in its most hideous aspect.

BUY LIBERTY BONDS

Mr. Belnap on Safety

The address delivered by Hiram W. Belnap, manager, Safety Section, United States Railroad Administration, at the annual congress of the National Safety Council, a condensed report of which appears elsewhere in our pages, is a notable contribution to the subject of increased safety in railroad operation. Mr. Belnap's analysis of casualties is illuminating. In the record of accidents extending over a period of five years the list of fatalities show that over 67 per cent. of the victims are persons who have no legal right whatever to be on the railroad, and whose safety is a subject that properly comes within the jurisdiction of the local authorities. The railroad authorities can neither make arrests nor inflict penalties on trespassers, but now when the management is largely in the hands of the Federal Government some action in the direction of dealing with trespassers may be expected.

At the same time the records show that 30 per cent. of all the killed and 90 per cent. of all the injured on the railroads in the United States are railroad employees. Statistics show that improved appliances have not lessened this deplorable condition. Mr. Belnap's conclusion is that those in authority do not sufficiently instruct the employees, and that there is no systematic method in general practice of educating the young railway men how to take care of themselves. This is true, and it will be interesting to observe how far the government will go in endorsing Mr. Belnap's views in establishing better methods of inculcating a stronger degree of caution in the minds of the railway men, not only towards the safety of the traveling public, but more particularly toward themselves.

Regarding the traveling public the statistics also show that less than 3 per cent. of the total fatalities occurring during the same period were passengers and persons carried under contract. This rate of fatal accidents to railway passengers as compared with fatalities on railroads generally is the lowest of which there are any authentic records, and speaks volumes for the care with which the passengers are safeguarded. And if the same degree of care could be exercised by the authorities in preventing trespass, and a similar degree of caution in the railroad employees in taking care of themselves, Mr. Belnap's hope of a lessened degree of accidents on railroads would be accomplished.

BUY LIBERTY BONDS

Workshop Accuracy.

In an address recently delivered before the American Society of Mechanical Engineers, New York, by Brig. General L. B. Kenyon, he discussed the absolute necessity, in shop work, of the greatest accuracy of workmanship and quality of material required in munition work. Among other things he referred to the rolling of thin steel sheets for shell bodies and told how material which came too near the piped end of steel ingots was apt to split while in the gun and cause a premature explosion by which not only the gun itself, the carriage, the sighting apparatus, the recoil mechanism, but the whole of the gun crew were blown to bits, and that "good enough" work often resulted in a costly wreckage of the weapon and the death of men working it.

In the matter of time fuses, it was necessary that they be made with the greatest nicety so as not to burn short and explode among our own men, nor too long and so go off away beyond the enemy. A battery six miles behind the allied lines firing over the near and friendly trench was required to explode shrapnel or timed shells close above or in the hostile trench when there might not be 100 yards distance between the two. The manufacturers who succeeded best were those firms which were hardest on themselves and maintained a drastically severe inspection of their own product, and that those who failed or were compelled to go out of business were those who failed to appreciate the necessity of workshop accuracy in manufacturing and did not realize the terrible responsibility of those who make munitions.

Sometimes workmen, thoughtlessly or through ignorance, jeopardize the lives of those who are fighting for right and justice and who belong to the same nation which gives them the means to struggle on. The army must take what is sent them, in faith. They cannot test the shells, or the fuses of the explosives, nor can they file and fit new parts of a gun when a substitution must be made on the field. "Theirs not to reason why, theirs but to do or die," and they are now in the valley of death, looking with trust and faith to home and friends.

BUY LIBERTY BONDS

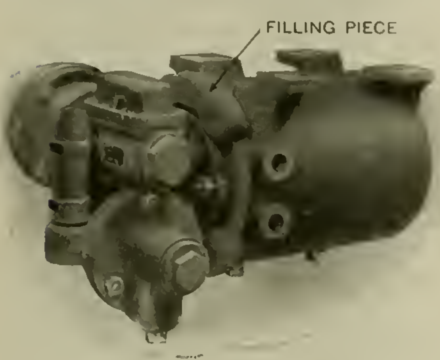
Goggles More Than Protective.

As some discrepancies and inaccuracies crept into Dr. Wm. T. Powers' article on "Goggles More Than Protective," as we were going to press for our September, 1918, issue, a more detailed and corrected statement of Dr. Powers' thesis will appear next month.

Air Brake Department

The No. 6.-A Distributing Valve—Questions and Answers

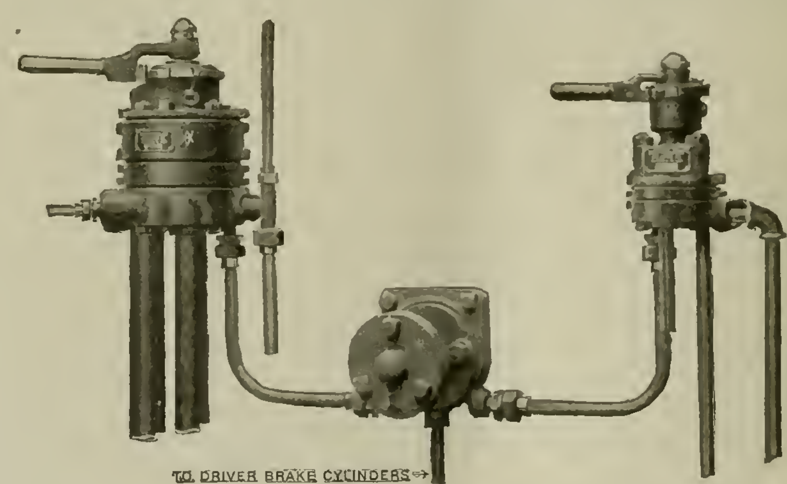
The distributing valves of the ET locomotive brake equipment furnished by the Westinghouse Air Brake Co. are now of the No. 6-A type, the photographic view showing this type of valve mounted on the reservoir and the filling piece containing a reduction chamber between the valve and reservoir. There is no difference whatever in the operation of the No. 6 and No. 6-A valves unless the filling piece or reduction chamber is used. We have mentioned this device under the heading of "Retarded application type of distributing valve" calling attention to the desirability of employing a locomotive brake cylinder operating valve that will not apply in advance of the train brakes, which results in rough handling from the alternate running in and out of slack especially when car brake operating valves of the PC and UC type are in use.



DISTRIBUTING VALVE AND FILLING PIECE.

As stated at that time, the reduction chamber in the filling piece is connected with the pressure chamber through the equalizing slide valve and graduating valve when the equalizing piston and attached graduating valve move from release position to engage the equalizing slide valve to move it to application position. The reduction chamber is of such size that the pressure chamber equalizes with it at a pressure of from 104 to 105 lbs. and thereafter a differential of from 3 to 5 lbs. between the pressure chamber and the brake pipe results in a movement of the piston and slide valve to service position, this requiring a total of from 8 to 10 lbs. brake pipe reduction. As soon as the equalizing slide valve moves, the reduction chamber is opened to the atmosphere through a separate exhaust port and the reduction chamber is again emptied, for a retarded application in the event of applications following in succession. With the 20 lbs. brake pipe reduction 45 lbs. application cylinder and brake cylinder pressure is obtained against 50 lbs. with the same valve when the reduction chamber is not used. This feature is also taken advantage of in preventing the creeping on of driver brakes after the train brakes have released, through the pressure chamber being charged to a higher pressure than that to which the brake pipe settles after the return of the brake valve to running position.

The release pipe valve shown is a device that prevents the failure of the application piston of the distributing valve to return to release position, due to abnormal friction when the driver brake cylinder pressure has been graduated down, this resulting in the retention of a light pressure in the locomotive brake cylinders. This is sufficient to cause annoyance, and sometimes overheated and loosened driving wheel tires, if the brake cylinders and connections are free from leakage. This valve operates in such a manner that when the brake cylinder pressure is reduced to the predetermined amount the release pipe valve opens the independent brake valve connection direct to the atmosphere. This insures that any air pressure that may leak into the application chamber of the distributing valve reservoir, while the equalizing slide valve may be on lap position from slight variations in brake pipe pressure that may exist through brake pipe leakage and a feed valve that is not sufficiently sensitive to respond and supply the leakage

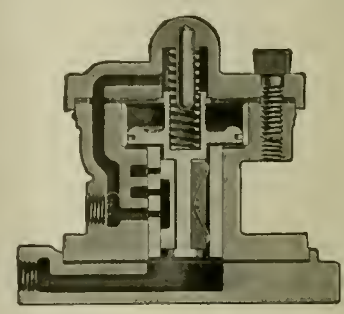


RELEASE PIPE VALVE AND CONNECTIONS.

promptly, will be discharged through the release pipe valve and the brake will be prevented from "creeping on."

The release pipe valve is so proportioned that when it opens the application chamber exhaust the brake cylinder pressure will be high enough to move the application piston back to normal or release position even if there is abnormal friction, thus there will be no possibility of any brake cylinder pressure being trapped when graduating the driver brake off.

It will be understood that both the filling piece for the No. 6-A valve and the release pipe valve are regarded as specialties, and are not supplied unless specially requested, as it is obvious that if the distributing valve is maintained in a reasonable state of efficiency there will be no frictional resistance to the movement



RELEASE PIPE VALVE.

of the application piston so abnormal as to require a special device in the form of a release pipe valve to obtain the release or complete release during graduations of the brake.

The release pipe valve may be used either alone or in conjunction with the retarded application type of distributing valve, and while the former may be considered as a refinement not absolutely essential there is a demand, and a practical necessity for the use of a retarded application type of distributing valve when the majority of the cars in the train have their brakes operated with universal valves or control valves.

Questions and Answers. Locomotive Air Brake Inspection.

(*Continued from page 292, Sept., 1918.*)

482. Q.—What if there is no additional space for the compressed air to expand into?

A.—The pressure per square inch will be increased.

483. Q.—In what proportion?

A.—In a direct proportion to the increase of temperature.

484. Q.—What would be the probable effect of heating a reservoir full of compressed air in a furnace?

A.—The temperature would likely produce sufficient pressure through expansion to burst the reservoir.

485. Q.—What causes a main reservoir to burst in service?

A.—An explosion.

486. Q.—How are the chemical elements necessary to produce combustion collected?

A.—From using a poor grade of oil in the air cylinder of the compressor and running the compressors when the engines are on the fire track.

487. Q.—How does running the compressor on the fire track enter into the question?

A.—By the compressor drawing in the fumes and gases from the burning coal, and hot cinders.

488. Q.—Have these gases any other bad effect?

A.—They destroy the lubrication in the cylinders, and they tend to destroy or eat up the inside of the reservoir.

489. Q.—Can this be prevented?

A.—To a great extent by shutting off the compressor on the fire track or using the enameled reservoirs.

490. Q.—What are the main reservoir pressures usually carried in passenger service?

A.—130 and 140 lbs.

491. Q.—In freight service?

A.—They vary from 100 to 130 lbs.

492. Q.—What prevents a back flow of compressed air from the main reservoir to the air compressor?

A.—The compressor discharge valves.

493. Q.—What prevents a back flow from the air cylinder to the atmosphere?

A.—The receiving valves.

494. Q.—What kind of compressors are the 9½ and 11-inch pumps?

A.—Direct acting.

495. Q.—The 8½ and 10½-inch pumps?

A.—Cross compound.

496. Q.—The New York No. 5 and 6-inch pumps?

A.—Duplex compressors.

497. Q.—Which types of these compressors compound the air pressure?

A.—The Cross compound and the duplex.

498. Q.—Which type uses the same steam in more than one cylinder?

A.—The cross compound.

499. Q.—What is the duty of the differential piston of the 9½ and 11-inch compressors?

A.—To move the main slide valve in the top head.

500. Q.—What is the duty of the main slide valve?

A.—To distribute the steam to, and exhaust it from the steam cylinders.

501. Q.—What does this do?

A.—Imparts movement to the main steam piston and rod.

502. Q.—What is the duty of the main steam piston and rod?

A.—To move the air piston in the air cylinder and to impart motion to the reversing valve rod.

503. Q.—What is the duty of the reversing valve rod?

A.—To operate the reversing slide valve.

504. Q.—What is the duty of the reversing slide valve?

A.—To admit live steam to, and exhaust it from, the chamber at the outside end of the large piston of the differential valve.

505. Q.—What does this result in?

A.—The alternate movement of the differential piston structure.

506. Q.—In what manner?

A.—By alternately balancing and unbalancing the pressure surrounding the large piston of the differential valve.

507. Q.—When does this structure move in the direction of the large piston end?

A.—When boiler pressure is effective in the chamber between the pistons and the outside end of the large piston is open to the atmosphere.

508. Q.—What causes the movement in this direction?

A.—It has the largest area exposed to live steam pressure.

509. Q.—Or in other words?

A.—Having the largest area exposed, it has the greatest amount of pull in pounds per square inch.

510. Q.—When can the smaller piston move the structure in the opposite direction and reverse the motion of the pump?

A.—When the steam pressure is balanced on both sides of the large piston.

511. Q.—Are there any slide valves in the cross compound compressor?

A.—One, the reversing slide valve.

512. Q.—What distributes the steam to these cylinders?

A.—The main piston valve.

513. Q.—What is the duty of the reversing valve of the compound compressor?

A.—Identically the same as that of the direct acting compressors.

514. Q.—At what point does steam from the boiler enter the compound compressor?

A.—In the main valve piston chamber.

515. Q.—With the compressor in operation, where does steam pressure go from this chamber?

A.—To the high pressure steam cylinder.

516. Q.—And from there?

A.—To the low pressure steam cylinder.

517. Q.—What controls the flow of steam to the cylinders of the duplex compressors?

A.—Two reversing valves, operated by valvs stems.

518. Q.—Are these slide valves?

A.—In the late types of compressors they are piston valves.

519. Q.—Is the steam compounded in this type of compressor?

A.—No, live steam enters both steam cylinders.

520. Q.—What is the principal difference in the piston movement between the compound and duplex compressors?

A.—With the compound both high and low pressure pistons are in motion at the same time, while with the duplex one piston is at rest while the other is in motion.

521. Q.—What is atmospheric pressure at the sea level?

A.—14.7 lbs. per square inch.

522. Q.—At about what rate does the pressure decrease for higher altitudes?

A.—About one-half pound for every additional 1,000 ft. in altitude.

523. Q.—Has this any effect upon the efficiency of the air compressor?

A.—Yes; the higher the altitude, the lower the efficiency of the compressor or the less the capacity, all other things remaining equal.

524. Q.—In just what manner?

A.—Instead of having a pressure of 14.7 lbs. in the air cylinder at the beginning of the stroke, it may have but 12 or 13 lbs. at a high altitude, thus requiring more strokes of the compressor per minute to compress a given volume of free air.

525. Q.—Commencing with about 15 lbs. atmospheric pressure in the cylinder, what amount of pressure will be in the compression end of the cylinder when the piston is half way through cylinder?

A.—30 lbs. absolute pressure.

526. Q.—What is meant by absolute pressure?

A.—The actual or gauge, plus the atmospheric.

527. Q.—What would an air gauge register on a cylinder with 30 lbs. absolute pressure?

A.—15 lbs.

528. Q.—Why?

A.—Because air gauges do not register atmospheric pressure.

529. Q.—Under the same conditions, what would the cylinder pressure be when the piston was three-fourths of the way through the cylinder?

A.—60 lbs. absolute or 45 lbs. gauge pressure.

(To be continued.)

Train Handling.

(*Continued from page 293, Sept., 1918.*)

508. Q.—In double heading with the two engines at the head of the train, which engine should start first?

A.—The head engine.

509. Q.—When should the second engine begin to use steam?

A.—After the head engine has started the entire train.

510. Q.—What if the head engine cannot start the train?

A.—It should be allowed to almost stall before giving any assistance.

511. Q.—What will starting the two engines at the same time cause?

A.—It will cause a severe shock in the train if a portion of the slack is bunched at the time.

512. Q.—With the helper at the rear, which should be the first engine to use steam?

A.—The engine at the rear of the train.

513. Q.—When should the head engine be given steam?

A.—When the rear engine has started the train or after it becomes evident that the rear engine has stalled.

514. Q.—What should be done if it is necessary for the head engineman to take slack in order to start the train?

A.—He should give a whistle signal "apply brakes" before attempting to take the slack and the rear engineman should understand this signal.

515. Q.—What if the head engine is unable to start the train after taking the slack?

A.—The rear engineman should give the signal to apply brakes and take slack from the rear and attempt to start the train.

516. Q.—When two engines are ahead of the train, which one should take the slack?

A.—The head engine.

517. Q.—Of what use is sand in making in application of the brakes?

A.—It tends to prevent wheel sliding.

518. Q.—In what manner?

A.—By primarily creating a greater adhesion between the wheels and the rail.

519. Q.—Why is this of importance?

A.—Because wheel sliding is generally produced by a damp or greasy condition of the rail, and the use of sand tends to counteract this effect.

520. Q.—How should the helper engine on the rear be handled when a brake application is made from the head engine?

A.—The rear engine should keep on using steam to keep in the slack.

521. Q.—How should the throttle be handled when the rear engineman cuts off with the train in motion?

A.—He should ease off the throttle by degrees to allow the slack to change as gently as possible.

522. Q.—What must be done before a signal to proceed down a grade is given?

A.—The necessary number of pressure retaining valves must be turned up in accordance with the instructions.

523. Q.—Should a train be controlled down a grade by hand or air brakes?

A.—Trains must be controlled by air brakes supplemented by hand brakes when necessary.

524. Q.—How many hand brakes should be used if their use is necessary?

A.—Only as many as are actually required.

525. Q.—Why is this?

A.—Because the use of hand brakes tends to increase the number of cracked and slid flat wheels and it interferes with good braking.

526. Q.—Is there anything to be observed in connection with the air compressors before starting the descent of a grade?

A.—The compressors should be known to be operating correctly and the steam and air cylinders known to be well lubricated.

527. Q.—Why is this?

A.—Because in the descent of the grade the work required from the air compressors is the heaviest, and they are more liable to overheat or stop at this time from a lack of sufficient lubrication.

528. Q.—What should be done where there is a gradual loss of air pressure during the descent of the grade?

A.—The train should be stopped and fully recharged while there is still ample pressure with which to make the stop.

529. Q.—What two things must be constantly observed during the descent of the grade?

A.—Speed and air pressures.

530. Q.—What is indicated with high speed and low air pressure?

A.—Danger.

531. Q.—And with low speed and high air pressure what?

A.—Safety.

532. Q.—Where an error in judgment during release and recharge, necessitates either a high speed or re-application of brakes before the train is amply recharged, what should be done?

A.—The application should be made with the partial recharge and the speed reduced, care being taken to avoid repeating the mistake.

533. Q.—The principal aim in grade braking should then be what?

A.—To keep the speed down and the auxiliary reservoirs recharged.

534. Q.—How is this best done?

A.—By relatively short holds or frequent recharges.

535. Q.—What is the most dangerous condition in descending?

A.—Brake pipe leakage that does not show readily, and that permits the train to descend at a uniform rate of speed while the pressures are being depleted.

536. Q.—What does this result in, if brakes are held on for a considerable length of time?

A.—A loss of train control, possibly a runaway.

537. Q.—How does this leakage affect the brakes?

A.—The brake pipe leakage tends to supply brake cylinder leakage from the auxiliary reservoir until no reserve braking force is left.

538. Q.—What should be done to avoid these depletions in pressure?

A.—Make somewhat heavier brake applications and recharge at every opportunity.

539. Q.—In what position should the brake valve be for the recharge?

A.—In release position to make the recharge as rapid as possible.

540. Q.—When should running position be used?

A.—When the pressure can be maintained with the handle in running position, and for several seconds before making a brake application when the recharging is being done entirely from release position.

541. Q.—What is this for?

A.—To permit an opportunity for a partial equalization of pressure throughout the brake pipe, and avoid, so far as possible, the tendency for undesired quick action to occur.

(*To be continued.*)

Car Brake Inspection.

(*Continued from page 294, Sept., 1918.*)

477. Q.—If a triple valve is found that fails to apply or release upon the specified difference in pressure, what should be done?

A.—It should be removed and replaced by a tested valve.

478. Q.—How should a triple valve be cleaned, in a general way?

A.—By removing all of the grease and oily substance with some fluid that will evaporate and leave the parts perfectly dry.

479. Q.—What should then be done?

A.—The parts should be further cleaned with a compressed air jet.

480. Q.—What is the essential condition of the piston bushing?

A.—That it is straight, that is, not worn in any manner.

481. Q.—How must the packing ring fit?

A.—It must fit the bushing, and the piston groove and the ends of the ring must be very near together when the ring is in place.

482. Q.—Is this determined by removing the ring from the groove?

A.—No it can be determined without removing the ring.

483. Q.—What is very frequently the result of removing the ring from the piston groove?

A.—It is frequently sprung in a manner that renders it unfit for further service.

484. Q.—What is a good rule to follow in reference to the removal of rings?

A. They should not be removed from the groove except for the purpose of renewal.

485. Q.—How should a new ring be fitted?

A.—As a general proposition this should be left to the manufacturer.

486. Q.—For what reason?

A. The manufacturer is prepared to do the work accurately without damaging the piston bushing also by the time a ring is worn out, the piston bushing will also be worn to an extent that it may require truing up.

487. Q.—If it is absolutely necessary to fit a new ring and the bushing is not materially worn, how is it done?

A. The ring is first rubbed down on a surface plate to a neat fit in the piston groove, and thereafter the ends are filed until they lap over just a mere trifle at the ends, so that some friction will be encountered in forcing the piston and ring through the bushing, by the time the ring is then rubbed through the bushing sufficiently to reduce the friction to the desired point, the ring will have a perfect bearing all the way round in the cylinder.

488. Q.—What is the general result of truing up bushings and fitting packing rings in railroad shops?

A.—It contributes its full share to the air brake troubles from undesired quick action, stuck brakes and slid flat wheels that are being encountered in railroad service at the present time.

489. Q.—How should a slide valve and seat be trued up?

A.—In any manner that will leave the valve and seat perfectly level, and free from leakage in any position of the slide valve.

490. Q.—How should a triple valve be lubricated?

A.—There is a question as to whether it should be lubricated in any manner whatever, but if anything is used it should not be moist.

491. Q.—What is the objection to a moist lubricant?

A.—It collects the dust that passes through the triple valve and makes what is termed a "dirty" triple valve.

492. Q.—How does dust enter the triple valve?

A.—It is always present in the atmosphere about railroad trains.

493. Q.—What becomes of the dust if it is not collected by moisture in the triple valve?

A.—The greater part passes out to the atmosphere in the same way that it enters, that is, dust that enters the triple valve will pass to the brake cylinder or to the auxiliary reservoir or through the triple valve exhaust port back to the atmosphere.

494. Q.—How should the ring be tested for leakage on the test rack?

A.—According to the standard code, while the ring, groove and bushing are perfectly dry.

495. Q.—Why is ring leakage so frequently found to be excessive a short time after the triple valve is placed in service?

A.—The ring leakage present is packed by oil or grease when the valve is tested on the rack and after it is absorbed or blown off in service the leakage remains, that is, the leakage is not detected when the valve is on the test rack on account of the oil packing about the ring.

496. Q.—What other fit in the triple valve is important?

A. About the most important fit is the piston in the bushing, regardless as to the condition of the packing ring.

497. Q.—Why should the triple valve piston fit the bushing?

A.—For the same reason that air pump, pistons and governor pistons must fit their cylinders, that is, to prevent leakage past the ring.

498. Q—What then is the result of scraping, rolling or reaming piston bushings in an effort to true them up for the renewal of a packing ring?

A.—A ruined triple valve through an enlarged piston bushing and consequently a piston that cannot fit the bushing.

499. Q—What is wrong with a triple valve that permits a waste of air through its exhaust port when the valve is in release position?

A.—Some part of the valve is defective.

500. Q.—Where will the leak be from?

A.—Either from the auxiliary reservoir or from the brake pipe.

501. Q.—How can the difference be distinguished?

A.—By closing the cut-out cock in the brake pipe branch leading to the triple valve.

502. Q.—If the leak is from the brake pipe, what will occur?

A.—The reduction in brake pipe pressure will instantly apply the brake as the small volume between the triple valve and the cut-out cock will quickly reduce.

503. Q.—Where would such a leak be from?

A.—Either from a leaky emergency valve seat or from a leak through the check valve case gasket.

504. Q.—Would it be necessary to distinguish the difference?

A.—No, the check valve case must be removed in order to make an examination of either part.

505. Q.—How will the brake act when the cock is closed if the leak is from the auxiliary reservoir?

A. The brake will not apply because there will be no brake pipe reduction.

506. Q.—From what parts could this leak be?

A.—From a leaky triple valve body gasket, or from a leaky slide valve.

507. Q.—How would the difference be ascertained as to which part is at fault?

A.—By re-opening the stop cock in the brake pipe branch and making a 10-lb. brake pipe reduction, if the blow stops it indicates that the body gasket is leaking but if the blow continues the slide valve is at fault.

508. Q.—How are you positive of this?

A.—If the slide valve is perfect it will close the triple valve exhaust port when the brake is applied.

509. Q.—Will this ever be varied?

A.—Yes, the slide valve may possibly be worn in a manner to be tight in one position and leaking in another and with quick service types of triple valves there are sometimes flaws in the check valve cases, and there is always a possibility of a flaw developing in a casting but anyone familiar with triple valve operation will have very little difficulty in locating the source of the leakage.

510. Q.—In freight car equipment there is another source of leakage at a triple valve exhaust port, where is this?

A.—A defective auxiliary reservoir tube.

511. Q.—How can this tube be tested?

A.—By bolting a triple valve in place with the brake cylinder port blanked. A leak from the non-pressure end of the cylinder will then indicate a defective tube.

(To be continued.)

Save Oil

The request of the President that joyriding and the general unnecessary use of automobiles be discontinued on Sundays, although not a law, has received even a more scrupulous observance than any legislative enactment could have. The people showed by their ready grasp of the meaning and the occasion.

The oil division of the U. S. Fuel Administration has lately issued the following to still further direct attention to the matter of saving oil in all forms in which the writer says: "The conservation of fuel oil, gasoline, kerosene and lubricating oils is necessary, otherwise a shortage in their supply may result. The Oil Division of the Fuel Administration desires to bring this fact to your attention and to ask your aid in stopping the waste of oil in all forms. Realizing much oil, of various kinds and used for numerous purposes, comes under the direction of many of your readers, I ask that copies of this letter be placed in the hands of each. (I shall be glad to send you sufficient copies if you will state the number needed.) By way of making a start, I suggest that each railroad officer inspect the plant with which he is connected, and, if any oil is found on the ground, floors, or engine beds, etc., to issue instructions to the operators to have the waste stopped. It is the drops that count!

Powerful Punching and Shearing Machines

The promptitude with which the railroads have met the great national emergency in transportation, finds its equivalent in naval construction and seamanship, and coincident with these are the machine constructors who have made rapidity and uniformity and reliability of construction possible. The superiority of American manufacturers of machinery is so well known and universally conceded that it need hardly be referred to. In earlier years it could be heard that America excelled in light machinery, but we have outgrown this, and some of the machines now being delivered in France could not and now cannot be duplicated in Europe. It should be remembered that many of our American firms engaged in the construction of machinery have been employed in the work for many years, and are constantly striving after improvements. Among these the Long & Allstatter Company, Hamilton, Ohio, have earned an enviable reputation. Sixty years have elapsed since the first power punch was built by the founders of this firm, and the machine is still doing active duty, and bids fair to do good service for many years to come.

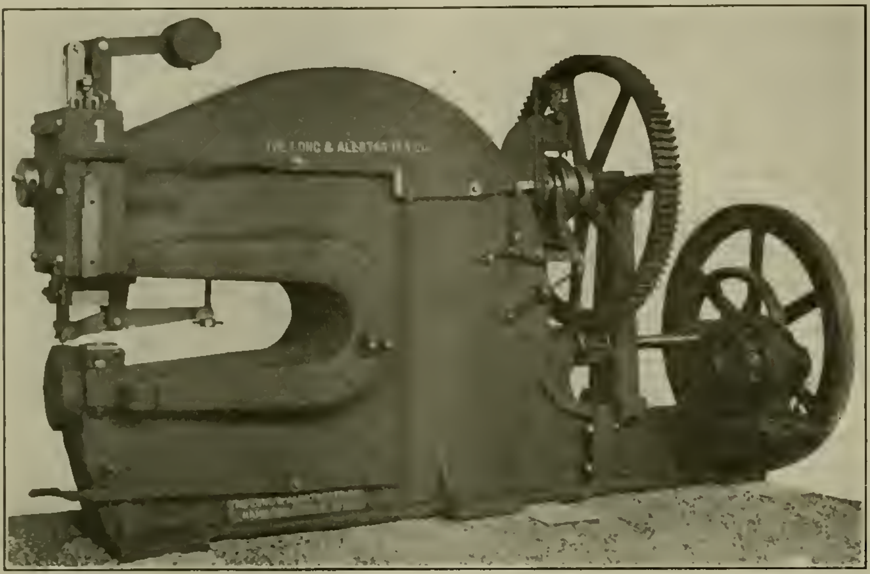


FIG. 1.—SINGLE PUNCHING AND SHEARING MACHINE.

Coming to present day practice, our illustrations show two of the company's machines, one or other of which may be seen in nearly all the larger railroad shops. Fig. 1 shows a single type of punching and shearing machine, being a modified form of the regular or standard machine for boiler shop use. It will be observed that the end of the lower jaw is rounded, and the tools are adjustable so that it will punch flue, hand and rivet holes close in the corner of the flange on boiler heads and other circular forms, and by reason of this ready adaptability, this form of construction is commonly known by the term "boiler form," and may be used on any size machine.

The capacity of the machine as shown with 42 ins. throat will punch $1\frac{1}{2}$ ins. hole through 1 in. thickness, and will shear 8 ins. by 1 in. flat bars, 2 ins. round bars, and will also shear with equal facility 5 ins. by 5 ins. by $\frac{3}{4}$ in. angles. The machine will also split $1\frac{1}{2}$ in plates. It is also equipped with motor drive and automatic stop.

Fig. 2 shows a double machine with 15-in. throats. This machine is adapted to drive by belt or electric motor, and in common with the company's products is made of the best material, the body or main frame of the machine, the slides and the gearing being of semi-steel, the cam pintles that give movement to the slides are made from steel castings bushed with phosphor bronze. Gibs also of phosphor bronze are provided for taking up the wear on the slides. The clutch, and the clutch face, bolted to the hub of the main gear on the respective sides are made from high carbon steel castings. The cam or eccentric shafts are made from hammered open hearth steel forgings, and run in phosphor bronze bushed bearings in the head of the machine. Provision is made for turning the cam shafts by hand for convenience in setting and adjusting the tools.

The machine will punch 1-in. hole through 1-in. thickness, and shear 6 ins. by 1-in. flat bars, and shear $1\frac{3}{4}$ ins. round bars, 4 by 4 by $\frac{3}{8}$ ins. angles, and split $\frac{7}{8}$-in. plates.

The company manufactures a large number of sizes and varieties of standard single and double machines ranging in capacity from the smallest to the largest, with a large number of specially designed tools for special purposes.

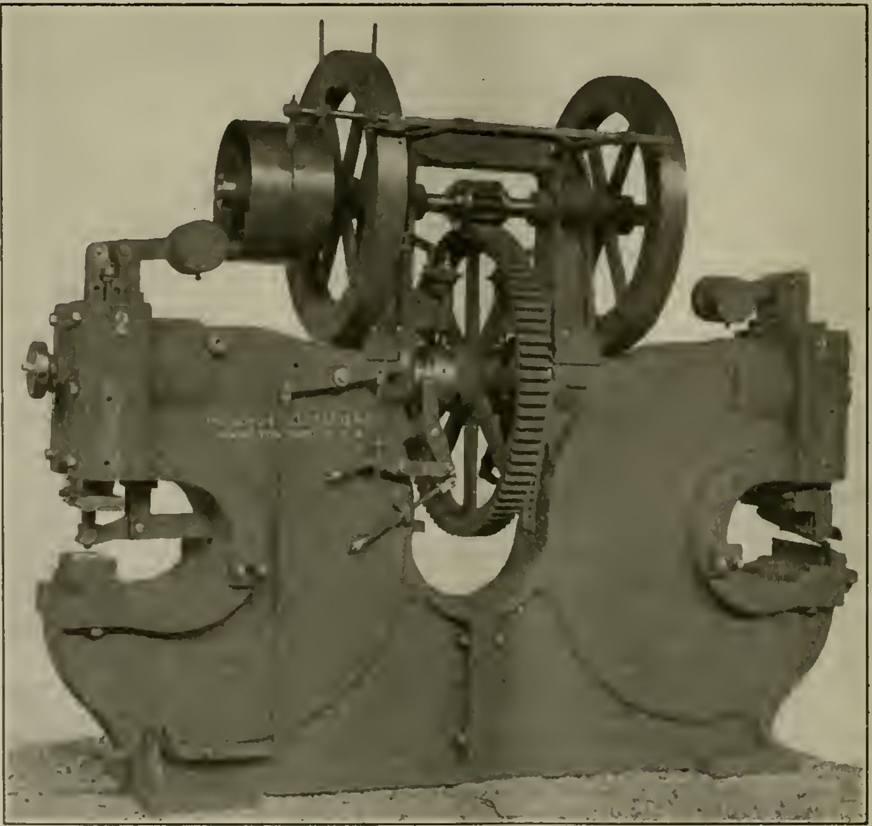


FIG. 2.—DOUBLE TYPE OF PUNCHING AND SHEARING MACHINE.

A Method of Saving Coal.

The report of the committee of the American Railway Master Mechanics' Association, on Fuel Economy and Smoke Prevention, has just been issued. Mr. William Schlafge is chairman of the committee, which is made up of Messrs. W. H. Flynn, D. M. Perine, R. Quayle, D. J. Redding, and W. J. Tollerton.

They point out that according to the official figures, in 1917 the railroads consumed 155,000,000 tons of coal. Estimates of the Fuel Administration indicate that the consumption in 1918 will aggregate 166,000,000 tons, an increase of 7 per cent. over last year. It is believed that this entire estimated increase can be avoided and a substantial saving effected if the earnest co-operation of every railroad employee can be enlisted in the application of individual economies. The United States Fuel Administration in an official statement said that "A saving of 60,000,000 tons of coal was the one possible avenue of escape. The necessities of war must be supplied. The coal deficit must inevitably come out of the necessary fuel for non-war industries. These industries employ millions of our population and furnish the backbone of our national wealth. Factories will shut down and men be out of work in proportion to the coal deficit. Every ton of coal saved will keep fifty workmen from idleness and permit additional creation of several hundred dollars' worth of national wealth. The Fuel Administration has frankly given to the public statistics of the fuel situation. It desires to state just as frankly that it is in the power of the American people, through fuel economy, to save the country from the effects of the fuel famine.

Of the 60,000,000 tons of coal, the Fuel Administration states that a million and a quarter tons per month could be saved by such simple methods that any man suing fuel on a railroad could at once apply for additional apparatus or personal instruction. These men have only to be impressed with the importance of the subject to make the required saving. The committee believes that every road foreman, supervisor, traveling engineer and fireman should be immediately acquainted with the situation so that its importance may be understood by every engine crew in the country.

But this probable shortage in the supply is not the only factor that demands our consideration. The fact is, that in the opinion of the Fuel Administration it is physically impossible to transport all the coal needed, so that it may fairly be concluded that the difficulty is mainly one of transportation. And this, at the present time, is vital not only to our economic necessities, but to the success of our arms abroad. This means that for every pound of coal saved, a pound of another needed commodity may be transported.

A saving of 10 per cent. in the coal consumption on American railroads means a reduction in demand of 332,000 cars, which is the approximate equivalent of 8,300 tons a year, representing a movement in the winter months of 800 trains a month. If this 10 per cent. could be begun at once, the reserve supplies could be increased, so as to show by December 1, 1918, fully 6,000,000 tons. Previously the committee named a definite standard of quality. The necessity of using all the coal in the ground was emphasized. The increased demand for the last three years has tended to let in coal of inferior quality. The impurities accepted affect our commercial and industrial efficiency. They reduce the efficiency of power plants, increase the necessity for excess plant capacity, they reduce the available units of transportation, increase the cost of labor per ton of combustible transported, unloaded and utilized. They not infrequently reduce plant output, and always impair locomotive performance.

In every contract between operators and miners it is agreed to, and upheld by the United Mine Workers, that there is a penalty on miners who load impurities with coal when the impurities could reasonably be kept out. It is the duty of the railroads to insist on clean coal, to apply rigid inspection methods, and to co-operate with the mine officials in securing a higher average in the quality of the coal supplied.

There is not an element of locomotive maintenance that does not in some degree affect fuel consumption. Any neglect to make needed repairs to a boiler or any part of the machinery, or any failure to make such repairs properly, is reflected in operation. Moreover, there are features of car maintenance that are intimately related to the coal consumption so that the question is one which should have large general interest to all employees of the mechanical department.

In order that the matter may be brought to the attention of those concerned briefly and comprehensively, a tabulation has been made indicating those details most affecting fuel economy in a properly designed locomotive. They have been arranged in what appears to be the order of importance.

A very common cause of poor steaming locomotives is a leak in the boiler front door which is frequently compensated for by a reduction in the area of the exhaust nozzle, thereby placing a double burden upon the boiler and the coal supply further back. Every report of a poor steaming locomotive now requires immediate and special attention. We should so organize and instruct our forces as to insure prompt investigation and the application of the proper remedy in every instance.

Probably there is no single source of immediate and absolute waste greater than at the ash pit. Every pound of unconsumed combustible that finds its way to the ash pit is a direct loss, and the total aggregates large proportions. It is, of course, impossible to eliminate this waste entirely, but it can be minimized by proper firing methods so that the locomotives reach the pit with light fires, by dumping the engines as soon as possible after arrival at the ash pit. Another prolific source of ash pit waste is caused by defective crane buckets and careless crane operation. Coal often drops from the buckets into the pit and is lost.

It frequently occurs that cars unloaded with clam-shell buckets are sent back to the mine, not completely unloaded, often, more than a ton remains. Every pound of coal should be removed. The unnecessary movement of engines and the excessive use of the air pump are important matters which in many cases admit of reform. Among other sources of economy which may be inaugurated about roundhouses, etc., is the elimination of waste that often occurs in the heating system. The coal basket and open coal fire should be done away with, often found at ash pits and water cranes. Another common source of heat loss frequently is found in steam pipes installed under ground, the course of which is often indicated by a line of melted snow, in the winter, and exposed piping is left uncovered.

Reference is made to the storage of coal which will undoubtedly be required to a greater extent than heretofore, not only because it permits the accumulation of large reserve supplies against extraordinary demands, but it accomplishes a stabilization of the entire fuel supply situation. In the past there have been huge losses because of the spontaneous combustion of stored coal, particularly bituminous, and this has not only resulted in loss of fuel, but has affected subsequent locomotive efficiency in some degree and made labor demands upon our organization at a time when labor could have been more advantageously employed elsewhere. The subject of storage of coal, with a view to prevention of spontaneous combustion, has received much study by

LOCOMOTIVE DETAILS.

MOST AFFECTING FUEL CONSUMPTION.

Boiler.		Engine.	Locomotive.	Air System.
Front end	Leaks........	Leaks:	Improper adjustment:	Air pump:
	Flues.......	Cylinder packing.......	Steam valves	Cylinder packing.
Flues	Superheater.	Valve packing	Shoes and wedges......	Rod packing.
	Mud ring...	Cylinder heads	Safety valves	Governor relief port
Brick arch	Firebox ...	Cylinder cocks	Worn or defective parts	
	Shell.......	Steam chests and covers.	not producing leaks:	Hose.
			Grate bars	Hose couplings.
			Tires	
			Rods	

various investigators, but the latest and most comprehensive treatment of the subject appears in the University of Illinois Bulletin Circular No. 6, on "The Storage of Bituminous Coal," by H. H. Stouk, Professor of Mining Engineering in the University.

INSTRUCTIONS FOR THE STORAGE OF BITUMINOUS COAL.

1. The risk of spontaneous combustion in stored bituminous coal increases with the percentage of slack, consequently as far as practicable only lump coal should be stored and this should be as free from dust and fine coal as possible. This consideration suggests the selection of the less friable coal for storage purposes.

2. The risk of fire from the storage of fine coal or slack may be minimized by the exclusion of air from the interior, which may be accomplished (a) by a closely sealed wall built around the pile, or (b) by close packing of the fine coal.

3. It is advisable that coal for storage purposes be as dry as possible. It should not be dampened when or after it is placed in storage.

4. Where a choice is possible, coal having low sulphur content should be shipped for storage purposes.

5. The risk of spontaneous combustion is minimized by so packing that air cannot enter the pile.

6. The segregation of fine and lump coal in the same pile should be avoided.

7. Where space permits, coal should be stored in low piles, divided by alleyways.

8. The different varieties should not be mixed and stored in the same pile.

Storage appliances and arrangements should be so designed as to permit the coal to be quickly removed and large piles should not be made when there is no provision for loading quickly.

In storing coal, care should be exercised to remove pieces of wood, greasy waste or other easily combustible material.

All storage piles should be regularly inspected and the temperature recorded. If the temperature reaches 150 degs. Fahr., the pile should be watched carefully, and if it rises to 175 or 180 degs. Fahr., the coal should be removed as quickly as possible. The temperatures should be taken at various places and at varying depths. A good thermometer should be used. Heretofore the problem of fuel economy has been approached with a view to its effect on operating expenses. Now we must go further to effect economy to conserve the available supply. As the Director General points out, "The Government now being in control of the railroads, the officers and employees of the various companies are no longer serving private interests. All now serve the Government and the public interests only." Co-operation is necessary; individual effort, indispensable.

Locomotive Exhaust Apparatus

The subject of locomotive exhaust appliances has engaged the attention of many clever engineers since the days of George Stephenson whose appliance of the exhaust steam in maintaining the draft in the fire box was undoubtedly the chief factor in the success of his "Rocket." Nozzles, circular, rectangular, and others furnished with internal projections have been experimented with and the end is not yet. A. G. Hentz, of Collinwood, Ohio, has just patented an improved device which it is claimed will materially increase the draft, and will not require so much restriction of the steam escape opening as is commonly the case, and in consequence will reduce the back pressure on the locomotive pistons.

The chief feature of the device is the use of a series of outlet openings con-

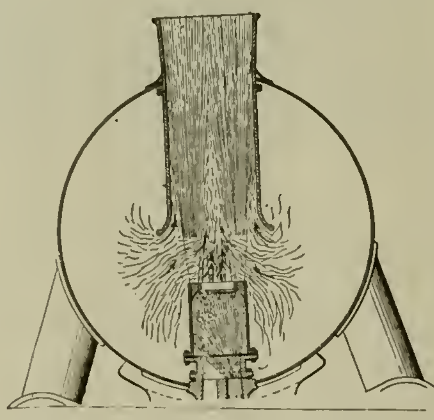


FIG. 1.

nected to a common chamber arranged to discharge the exhaust steam in a plurality of jets so disposed as to leave some clearance space between adjacent jets just at the point of discharge, insuring the junction of the discharging jets within the stack at some distance above the point of discharge. A reduction of noise incident in the discharge is also claimed.

Another object is that the products of combustion may be drawn in between the jets at a point beyond the place of discharge and entrain with the escaping steam upon the inside and throughout the mass as well as upon the outside, whereby the available entraining area of the steam is increased to a considerable extent, and also lessening the abrading or destructive action of the cinders carried with the escaping gases, the only part liable to be abraded being the top surface of the nozzle which can be easily and cheaply protected by any suitable detachable, or renewable wear plate.

Our accompanying illustrations show in detail the chief features of the device, Fig. 1 being a transverse sectional view of a portion of the front end of a locomotive through the exhaust nozzle and stack. Fig. 2 is a partial plan view of the nozzle itself, and Fig. 3 a sectional view of the exhaust pipe and nozzle. It will be observed that the exhaust pipe is made with a base part which carries a cylindrical portion, the upper end of which is closed at the center by a kind of plug or head wall supported in position by a plurality

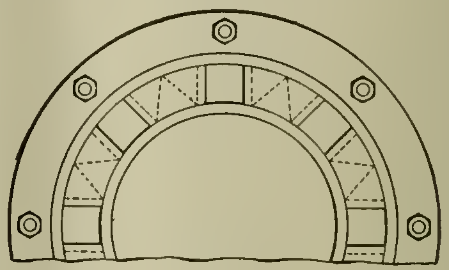


FIG. 2.

of spacing members holding the head in place, and also providing square-shaped exhaust apertures in a series arranged around the head and between the latter and the walls of the cylindrical chamber, the formation of the openings being such that they gradually approach each other as they expand at the same time that the discharging column of steam expands as a whole, and will therefore serve to substantially fill the interior of the stack at a point a considerable distance above the point of escape on the nozzle.

It may be observed that the number, size, shape and arrangement of the several members, and of the parts or separate

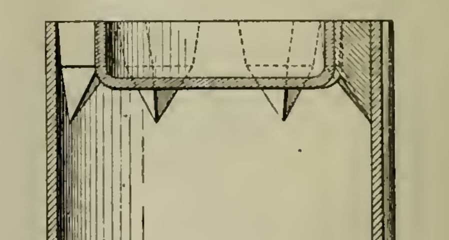


FIG. 3.

discharge apertures may not be limited to that shown in the drawing but may be varied as the conditions of service require to produce the most effective results.

British Railways and the War

BY ROBERT W. A. SALTER, LONDON, ENGLAND.

Some months having elapsed since the appointment of Mr. McAdoo to the responsible position of Director General of Railroads and a fair basis for comparison between the merits and demerits of the two administrations being thus afforded, the following paper, a résumé of the outcomings and experiences of nearly four years of Government control in Great Britain, will not come amiss.

It will be remembered that when war was declared the British Government exercised its legal powers and took over the railways of Great Britain. On August 4, 1914, the Secretary of State for War issued an announcement in the following terms:

"An Order in Council has been made under Section 16 of the Regulation of the Forces Act, 1871, declaring that it is expedient that the Government should have control over the railroads in Great Britain. This control will be exercised through an Executive Committee composed of general managers of railways which have been formed for some time, and has prepared plans with a view to facilitating the working of these provisions of the Act.

"Although the railway facilities for other than naval and military purposes may for a time be somewhat restricted, the effect of the use of the powers under this Act will be to co-ordinate the demands on the railways of the civil community with those necessary to meet the special requirements of the naval and military authorities.

"More normal conditions will, in due course, be restored, and it is hoped that the public will recognize the necessity for the special conditions, and will, in the general interest, accommodate themselves to the inconvenience involved."

The Regulation of the Forces Act under which the Government assumed control provided that full compensation should be paid to the owners for any loss or injury sustained in consequence, the amount to be settled by agreement, or by arbitration if necessary. The Government agreed with the railway companies concerned that compensation paid to them should be the sum by which the aggregate net receipts of their railways for the period during which the Government were in possession fell short of the aggregate net receipts for the corresponding period of 1913, subject, however, to a proportionate reduction if the net receipts of the companies whose net receipts for the first half of 1914 were less than the net receipts for the first half of 1913. The compensation paid under the arrangement covers all special services, such as naval or military transport, the Government consequently being liberated from the necessity of making payment on such transport.

Throughout the war relations between railway employees and the Government have been satisfactory. At the beginning of 1915 a war bonus was granted. This was later converted into war wages.

In April, 1915, the original terms of remuneration were modified. This relieved the railways from the proviso quoted above relating to the first half of 1914, and instead the railways agreed to pay 25 per cent of the war bonus granted to employees.

The passenger train services were considerably curtailed and decelerated; reservation of seats, compartments and saloons for private parties discontinued; operation of sleeping and dining cars curtailed; working of certain slip coaches and through cars off main line trains to branch lines discontinued; acceptance of road vehicles by passenger train prohibited; all passenger fares, except workmen's season, traders' and zone tickets, increased by 50 per cent; limitation made in the amount of baggage which passengers might have accompanying them on a journey. In regard to freight traffic, arrangements were made for the pooling of wagons, and to enable equation between various companies Great Britain was divided between twelve of the great systems, all other lines being allocated between these. More than a thousand stations and depots throughout the kingdom were closed to passenger, and, in some cases, to freight traffic.

In short, the aim of the Government was to discourage travel. But notwithstanding the efforts in this direction the volume of traffic on the railways appears now to be on an upward tendency, although there was a marked falling off after the raising of fares by 50 per cent. The Railway Executives feel, in these circumstances, constrained shortly to establish further curtailments, which will involve a reduction in the speed of express trains to 35 miles per hour. This will incidentally mean economy in fuel. Passenger fares are not to be increased again at present, since it would impose such a great hardship upon bona fide travellers.

"A recent census of passengers arriving in London by main line trains," says a London paper, "showed that 69 per cent of the total were in uniform. The most striking feature of these figures is that they do not refer to troop movements proper, that is, to special trains carrying soldiers, but to the individual soldiers and sailors on leave or in performance of military functions, such as escort duty. These facts," continues our contemporary, "have a very important bearing on both the railway congestion problem and the considerations of any reductions in passenger train services. In suburban traffic civilian passengers are in the majority."

Since the war the British public has been made familiar with innumerable forms of control, but not generally appreciated, or even known, is the fact that there existed before the war a body known as the War Council of Engineer and Railway Staff Corps. It was constituted in 1912, and the present Railway Executive Committee, consisting of eighteen general managers—whose duties, by the way, are equivalent to those of President in the United States—is its outcome. Machinery for controlling railways as a unit was, therefore, existing before the war.

The position of British railways in December, 1916, was that of 700,000 men employed in railway work in Great Britain over 130,000 had been taken for military or naval work. In February this year that number was increased by 39,896. So far as numbers are concerned, these have been practically replaced by women, or men physically ineligible for military service, but who came with no experience of the duties they had to perform. In 1916 the quantity of steel used for maintenance, renewals, etc., amounted to 60,000 tons, or 140,000 tons less than in pre-war times. Rolling-stock had suffered in the same way, the locomotive and car shops of the various companies having been diverted to the manufacture of shells and munitions of war. From the railway companies' own stock 18,000 wagons and 600 locomotives have been sent to France and other countries, while in the railway shops 2,000 20-ton box cars have been constructed for use in France; rails and ties for over 200 miles of track sent away, and something like 30 ambulance trains completed for the theaters of war.

In the House of Lords recently Lord Curzon said that, during the recent German offensive, reinforcements have been crossing the English Channel to France at the rate of 30,000 a day, without loss of a single life—another testimony to the efficiency of the transport system in Great Britain and of the Royal Navy.

The preceding remarks emphasize an error which has been commonly printed in the newspapers in America, namely, that of assuming that the ownership of railways has passed into the hands of the Government in the United Kingdom. It is only the result of the control having been left completely in the hands of railway officers themselves that elasticity of policy has been possible. The present system of control is admirable and will undoubtedly continue after the war.

Electrical Department

How the Locomotive Characteristic Curves Are Made—Electrical Tests on Railway Motors

Last month we took up the subject of electric locomotive characteristic curves. We explained how these curves determined the locomotive performance. They show the relation between the current, the tractive effort and the speed. We used a set of characteristic curves to illustrate a few problems and showed the relation existing between the speed, tractive effort and electric current used by the locomotive, and how to apply these curves and make practical use of them.

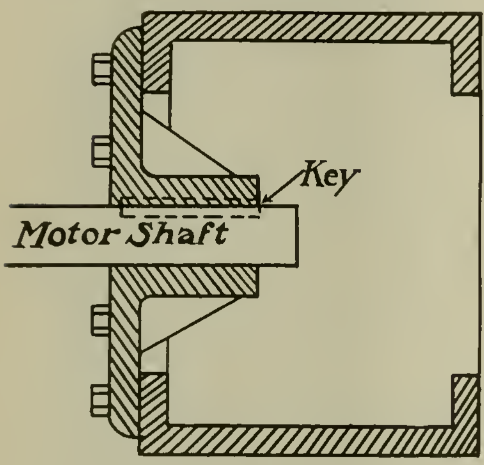


FIG. 1.—PULLEY WITH OUTSIDE FLANGE FOR HOLDING WATER.

We mentioned that it is the general practice to draw up these curves for the complete locomotive. We showed how these complete curves were used, but did not explain how the curves were made. We now desire to offer some explanation of the curves.

The characteristic curves show the true and exact performance of the locomotive and are worked out and drawn up from actual tests of the motors used on the locomotive. It should be clear that it is not necessary to wait until the locomotive is complete and ready for service before the test can be made. In fact it might be practically impossible to make a test of the complete locomotive due to lack of testing apparatus. To get the draw bar pull a dynamometer car would be necessary and few of these are available. Moreover it would be almost impossible to get simultaneous readings.

With an electric locomotive there is a unit of power, namely the electric motor. This unit is used in various numbers to make the complete locomotive; say four or eight or even more. Each electric motor is connected to the driving wheels in the same mechanical manner so that the relations as regards power delivered to the drivers is the same for all motors and the total power of the locomotive is a multiple of the power delivered by one motor, depending of course on the number of motors used in the construction of the locomotive. Therefore if the electrical characteristics of one motor is known the complete locomotive characteristics can easily be calculated.

The easiest and best way to get the electric motor characteristics is not on the locomotive when completed, but at the factory on the electric motor itself mounted on a test stand with all facilities readily available for making the tests.

The locomotive characteristic curves consist of an efficiency curve, a speed curve, a tractive effort curve, and a brake horse-power curve all plotted in reference to the current. The tests on the one motor should therefore be such that these curves are obtained.

An electric locomotive is required to work at all loads, from very light loads to heavy loads. In testing the electric motor it is therefore necessary to operate the motor over a wide range of load, from light load to full load, obtaining at these various loads the power delivered by the motor and the revolutions per minute.

The most direct method of testing a motor, is by the use of the Prony brake. It is also possible with the use of this brake to determine the efficiency of the motor. For large motors the pulley used is constructed in general as shown in Fig. 1. There is a flange on the outer end to retain what may be called a layer of water in the pulley when it is rotating. The pulley is hollow and open, with solid rim and flanges turned down, inward, and toward the centre. Two streams of water flow, one in and one out of the pulley. When rotating the centrifugal force keeps the water out against the inside of the rim and the flanges prevent it from spilling out. A pipe pours water into the interior of the pulley and another pipe with a scoop-end collects as much water as is fed in, by means of the wide end which rakes off a film of appropriate depth at each revolution. The pulley is always supplied with running water, inside, for purpose of keeping it cool when in use.

The brake itself consists of strips of wood placed all round the pulley and held together by steel straps. Under the wood is generally placed a sheet of asbestos, and under that is a sheet of brass, the brass bearing directly against the pulley. The tension is adjusted by a screw and hand wheel as is shown in Fig. 2.

When testing there is a large amount of heat generated due to the pressure of the brake against the pulley and some provision must be made to get this heat away. As mentioned above, the pulley is so constructed that a film or layer of water can be maintained in the pulley when rotating. A uniform thickness of water is thus maintained. It is essential that the brake band be kept well lubricated with grease, otherwise the brake might "bite" and so interfere with the tests.

To the brake band is fastened an arm, provided with a point, a known distance from the vertical line through the centre of the shaft, when the arm is horizontal. A convenient length is 3 ft. This point during tests is carried or rests on an ordinary pair of weighing scales so that the

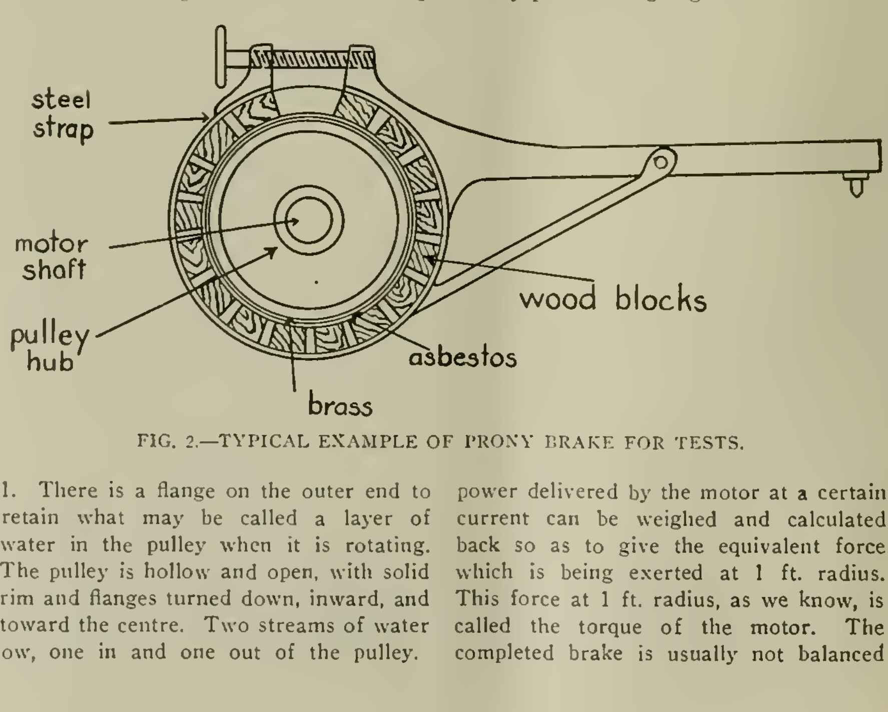


FIG. 2.—TYPICAL EXAMPLE OF PRONY BRAKE FOR TESTS.

power delivered by the motor at a certain current can be weighed and calculated back so as to give the equivalent force which is being exerted at 1 ft. radius. This force at 1 ft. radius, as we know, is called the torque of the motor. The completed brake is usually not balanced

when the arm is horizontal and it is necessary to subtract a constant amount from the readings of the weight on the scales. This quantity is found as follows. The brake is taken from the pulley and is supported on the vertical line mentioned above, by a V-shaped piece of wood, the other end resting on the scale. The weight as measured on the scale, or the "tare" of the brake, will be the amount which will be subtracted from all the readings, in order to obtain the true power.

The test of the motor is carried out something as follows. The motor is connected to the power supply and the brake is adjusted so that it represents a very light load. With this load kept constant for a minute or so, the speed in revolutions per minute of the armature is taken by a speed counter. At the same time the current used in the motor is taken, as well as the weight on the scale which is the pressure of the brake point. For this load we have the current reading, the speed and the torque of the motor. (The weight on the scale reduced to terms of pounds at one foot radius.)

These readings are then taken for a slightly heavier load and so on, point by point until full load condition is reached. Having obtained these readings for the several points, the locomotive curves can be drawn up by multiplying these readings of current and torque by the number of motors and changing over to terms of miles per hour and tractive effort by the use of the following formulas:

$$\text{Horsepower} = \frac{\text{Pounds torque} \times \text{Revolutions per minute}}{5252}$$

$$\text{Horsepower} = \frac{\text{Pounds tractive effort} \times \text{Miles per hour}}{375}$$

$$\text{Pounds tractive effort} = \frac{\text{No. gear teeth} \times 24 \times \text{Gear efficiency} \times \text{Pounds torque}}{\text{No. pinion teeth} \times \text{Inches wheel diameter}}$$

$$\text{Miles per hour} = \frac{\text{Inches wheel diameter} \times \text{No. pinion teeth} \times (\text{r. p. m.})}{336 \times \text{No. gear teeth}}$$

The various points are then plotted using the current readings as a base and the characteristic curves can thus be obtained.

BUY LIBERTY BONDS

Cold Facts About Coal.

It is stated on the very best authority, that of the U. S. Fuel Administration, that each fifteen thousand ton troop ship that puts American soldiers on the battle ground of France consumes more than 3,000 tons of coal or 12,000 barrels of fuel oil. More than 4,000,000 tons is used in moving the supplies that go forward to "our boys" or the Allies. These supplies must go forward, in one continuous, unbroken stream. There are no "ifs" nor "ands" to this fact, it is imperative, it cannot be argued about, and it is to make good in war what Kipling calls "loud waste that none may check."

Our shipbuilding programme requires 14,000,000 tons. This is for assembling the material alone, and in building eight million tons of vessels we use about 5 tons for every ship that leaves the ways. When it comes to thinking of warfare there are many citizens to whom the war is nothing but records of American and Allied prowess, or sole-stirring headlines in the daily papers. When it comes to actual war it takes 80 lbs. of coal in the manufacture of every 3-in. shell thrown by American guns in the world war for freedom. Larger shells use coal in proportion, and all kinds of explosive projectiles are made here by the million. It has been estimated by British authorities that to shell an enemy position or to maintain a barrage, more shells are used in an afternoon than were thrown in the whole Boer war. Under such a death-dealing storm, casualties are multiplied, and the transport of troops to the firing line and the systematic return of wounded men has taxed railway facilities, both here and in Europe.

It is when confronted by such untoward happenings that the Government, lenient as it must be in a republic, is forced by drastic measures to show the way to save, and to enforce it, so that the war may be won, as it must be and will be, for we are all resolved. But with the enormous war demand, added to the normal coal consumption of our railroads, industries and people, the United States is confronted with the necessity of supplying approximately 735,000,000 tons of coal during the year from April 1, 1918, to April 1, 1919. The gap bethween last year's production and this year's demands (at least 80,000,000 tons) must be bridged.

The production of coal, going as it does hand in hand with railroad service, increased tremendously during June and July of 1918. Records for bituminous production were established which the coal mining industry had never approached before. But as railroad service improves a heavy burden is laid upon the labor at the mines which must bring forth the coal. With the ranks of mine labor depleted by the demand for active service in the fighting line and by the shifting of labor to more remunerative work in war industry, there has developed the task of increasing the efficiency and output of the individual miner. To this end the Fuel Administration is bending every effort.

It is, however, encouraging to learn from a recent statement of the Director General that, among other things, he said: "Of late cars have been supplied to the coal mines more rapidly than they have been able to load them.

"The country has been led to believe that coal production is limited entirely by transportation and that any shortage is due to the railroads. This is erroneous. The maintenance of an adequate coal supply depends in the first instance upon production, which in turn is restricted by shortages of labor and other causes aside from transportation."

The reduction of paper for printing is part of the same movement for economy which is not only desirable, but an absolute necessity. Lumber jacks have been withdrawn from their regular work in Canada, from where most of our wood pulp comes, and there is also a scarcity of river drivers in the Dominion owing to the same cause. The manufacture of print paper takes coal, hence the restrictions.

From a census of the war industries and similar activities, undertaken by the United States Fuel Administration estimates since the declaration of war that the production of bituminous coal during the year beginning April 1, 1918, must be increased 79,866,000 net tons over the production of 1917, if estimated requirements are met. Unless this added production is accomplished, the requirements must be curtailed by conservation and by further limitation.

The ever-increasing fuel demand of the war machine has sent up the figures for the bituminous requirements for the current year to 634,594,000 net tons, while the production during 1917 was only 554,728,-000 net tons, although all previous production records were then broken by more than 52,000,000 tons. To meet the requirements an average weekly production of more than 12,200,000 tons was sure to be necessary throughout the coal year. On June 1, the first nine weeks of the coal year had expired and at that time the average weekly production had been so far below the requirement that for the remaining forty-three weeks of the coal year an average weekly production of more than 12,400,000 net tons was the programme necessary for fulfilling bituminous requirements.

The lesson of all this is a very practical personal appeal to the people of the United States, who of their own motion took up the instance of the right of small nations to live, and carried that insistence to the point of actual war. This war is not gratifying newspaper headlines, read hurriedly on the way to the office. It is a calamitous reality, as those in the trenches well know. Those who stay at home must turn their strenuous endeavors more strongly than before to an actual, concrete effort to save coal on the railways.

Items of Personal Interest

Mr. William A. Cotton has been appointed assistant to the general mechanical superintendent of the Erie, with office at Meadville, Pa.

Mr. Willard Wells has been appointed superintendent of motive power of the Atlantic Coast Line, with headquarters at Wilmington, N. C.

Mr. J. S. Peter has been appointed general manager of the San Antonio, Uvalde & Gulf, with headquarters at San Antonio, Texas.

Mr. W. A. Callison has been appointed superintendent of motive power of the Chicago, Indianapolis & Louiville, with headquarters at Lafayette, Ind.

Mr. W. G. Bierd, federal manager of the Chicago & Alton, has had his jurisdiction extended over the Peoria & Pekin Union and the Peoria Railway Terminal.

Mr. E. L. Brown, general manager of the Denver & Rio Grande, has had his jurisdiction extended to include the Salt Lake City Union Depot and Railroad Company.

Mr. Thomas S. Davey, formerly master mechanic of the Erie at Secaucus, N. J., has been appointed shop superintendent at Hornell, N. Y., succeeding Mr. Lee R. Laizure.

Mr. W. H. Sample, superintendent of motive power of the Grand Trunk at Montreal, Que., has been transferred to the western lines, with headquarters at Detroit, Mich.

Mr. J. Horrigan has been appointed superintendent of motive power of the Chicago, Milwaukee & Gary, and the Elgin, Joliet & Eastern, with headquarters at Joliet, Ill.

Mr. Oscar F. Ostby has been elected vice-president of Glazier Manufacturing Company of Rochester, N. Y. Mr. Ostby has offices in the Grand Central Terminal, New York.

Mr. E. T. Burnett will perform the duties of purchasing agent of the Norfolk & Western, in addition to his duties as chairman of the Regional Purchasing Committee for the Pocahontas Region.

Mr. William F. Murray has been appointed master mechanic of the New Jersey southern division of the Central of New Jersey, with office at Lakehurst, N. J., succeeding Mr. William Montgomery, retired.

Mr. A. E. Calkins, formerly assistant superintendent of rolling stock of the New York Central Lines East, has been appointed engineer of rolling stock of the New York Central Lines, with office at New York.

Mr. J. W. Small, formerly superintendent of motive power, Seaboard Air Line, has been appointed staff officer, mechanical, in the organization of the Southern regional director, with office at Atlanta, Ga.

Mr. A. B. Ford, formerly division master mechanic of the Great Northern at Great Falls, Mont., has been promoted to general master mechanic, with headquarters at Great Falls, succeeding Mr. J. J. Dowling, transferred.

Mr. A. G. Delany, formerly salesman for the American Brake Shoe & Foundry Company, with headquarters at Chicago, Ill., has been appointed local manager of that company at Minneapolis, and sales manager in the northwestern territory.

Gen. Guy E. Tripp, formerly Colonel United States Army and head of production division, has been promoted Brigadier General, and placed in offices having charge of the production of ordnance material. Previous to his connection with

GEN. GUY E. TRIPP.

the Ordnance Department, General Tripp was chairman of the Board of Directors, Westinghouse Electric & Manufacturing Company, with headquarters in New York.

Mr. S. G. Strickland, Federal manager of the Chicago & North Western, with headquarters at Chicago, Ill., has had his jurisdiction extended over the Fort Dodge, Des Moines & Southern, and the Waterloo, Cedar Falls & Northern.

Mr. D. M. Case, signal and electrical engineer of the Southern Railway lines west, with headquarters at Cincinnati, Ohio, has had his jurisdiction extended over the Georgia Southern & Florida, and the Alabama and Vicksburg railways.

Mr. E. E. Calvin, federal manager of the Union Pacific, the Oregon Short Line, the St. Joseph & Grand Island, and the Los Angeles & Salt Lake, has had his jurisdiction extended over the Ogden Union Railway and Depot Company.

Mr. W. F. Thiehoff, formerly assistant to the general manager of the Chicago, Burlington & Quincy, has been assigned to temporary service as active general manager of the Denver & Salt Lake, with headquarters at Denver, Colo.

Mr. Clarence H. Norton, formerly master mechanic of the Susquehanna, Tiogo and Jefferson divisions of the Erie, has been transferred to the Allegheny and Bradford divisions, with headquarters at Hornell, N. Y., succeeding Mr. A. J. Davis.

Mr. John Burns, formerly master mechanic of the Quebec district of the Canadian Pacific, at Montreal, Que., has been appointed assistant works manager of the Angus shops at Montreal, succeeding Mr. J. W. Buckland, granted leave of absence.

Mr. George McCormick, general superintendent of motive power of the Southern Pacific, has had his jurisdiction extended over the Western Pacific, the Tidewater Southern, and the Deep Creek Railroad, with headquarters at San Francisco, Cal.

Mr. J. J. Dowling, formerly general master mechanic on the Great Northern, with offices at Great Falls, Mont., has been appointed general master mechanic of the eastern district, with offices at St. Paul, Minn., succeeding Mr. G. A. Bruce, deceased.

Mr. E. R. Battley has been appointed superintendent of motive power of the Grand Trunk, Eastern lines, with headquarters at Montreal, Que., and M. A. McDonald has been appointed assistant superintendent of motive power of the same division, also with offices at Montreal.

Mr. R. E. Roe, formerly general master mechanic of the Gulf Coast Lines, has been appointed assistant mechanical superintendent of the New Orleans, Texas & Mexico, the Beaumont, Sour Lake & Western, and the St. Louis, Brownsville & Mexico, with offices at Kingsville, Tex.

Mr. J. E. Taussig, general manager of the Wabash, has been appointed Federal manager of that road, including such of its leased and operated properties under Federal control, with headquarters at St. Louis, Mo. Mr. Taussig has also had his authority extended over the Toledo, St. Louis & Western.

Mr. G. W. Saul, purchasing agent of the Oregon-Washington Railroad & Navigation lines, and the Yakima Valley Transportation Company, has been appointed purchasing agent also of the Southern Pacific Terminal of Oregon and the Pacific Coast with headquarters at Portland, Ore.

Mr. J. J. Carey, general master

mechanic of the Texas & Pacific at Dallas, Texas, has also been appointed general master mechanic of the Louisiana Railway & Navigation Company's lines west of the Mississippi river, and the trans-Mississippi terminal, with headquarters at Dallas.

Mr. Oscar E. Wolden, assistant fuel supervisor of the Minneapolis, St. Paul & Sault Ste. Marie, with headquarters at Minneapolis, Minn., has been appointed acting fuel supervisor, succeeding Mr. R. L. Pyle, who, as announced last month, was appointed supervisor of fuel conservation for the Central Western Region, United States Railroad Administration.

Mr. C. G. Burnham, federal manager of the Chicago, Burlington & Quincy, the Quincy, Omaha & Kansas City, the Toledo, Peoria & Western, west of Peoria, including the Peoria Terminal, the Rock Port Langdon & Northern, and the Rapid City, Black Hills & Western, has had his jurisdiction extended to include the Illinois Terminal and the Missouri & Illinois, Bridge and Belt.

Mr. D. J. McCuaig has been appointed superintendent of motive power of the Grand Trunk, Ontario lines; with headquarters at Toronto, Ont., and Mr. J. Vass has been appointed assistant superintendent of motive power of the Ontario lines, with headquarters at Allendale, Ont., and Mr. J. R. Leckie becomes assistant to the superintendent of motive power of the Ontario lines, with headquarters at London, Ont.

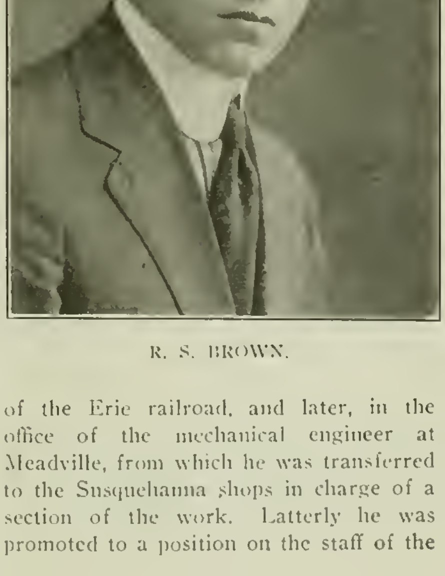
Mr. H. R. Safford, formerly chief engineer of the Grand Trunk Railway System, has been appointed engineering assistant to Mr. H. Holden, Regional Director of the Central western district, embracing the Santa Fe, Rock Island, Chicago & Alton, Union Pacific and other railways. Mr. Safford is a graduate of Purdee University, and a now vice-president of the American Railway Engineering Association.

Mr. C. H. Ewing, Federal manager of the Philadelphia & Reading, the Central Railroad of New Jersey, the New York & Long Branch, the Atlantic City, the Port Reading, and the Staten Island Rapid Transit Railroad, has had his jurisdiction extended over the Staten Island, the Baltimore & New York, and the Baltimore & Ohio properties and piers on Manhattan Island, which lines and facilities have been released from the jurisdiction of Federal manager, Mr. A. W. Thompson.

Mr. H. E. Chilcoat, representative of the Westinghouse Air Brake Company in the Pittsburgh district, has accepted a position as manager of the Clark Car Company, manufacturers of the Clark Extension Side Dump Car. Mr. Chilcoat entered railroad service in the employ of the Pennsylvania in 1900 as machinist's apprentice, and served successively as work inspector, gang foreman and foreman of the air brake department until 1906, when he entered the service of the Westinghouse Air Brake Company as traveling inspector, and shortly after was assigned to the southeastern district with office at Richmond, Va., and in 1910 to Pittsburgh, as noted above.

H. E. CHILCOAT.

Mr. R. S. Brown, vice-president of the G. M. Basford Company, and whose election was noted in the Septemher issue of RAILWAY AND LOCOMOTIVE ENGINEERING, is a graduate of Pratt Institute. In 1909 he entered railway service as a special apprentice in the Meadville shops of the Erie railroad, and later, in the office of the mechanical engineer at Meadville, from which he was transferred to the Susquehanna shops in charge of a section of the work. Latterly he was promoted to a position on the staff of the general mechanical superintendent at New York. On the formation of the G. M. Basford Company two years ago Mr. Brown became associated with the new enterprise and has shown an admirable adaptability to the requirements of the office, with the result that he was elected vice-president as noted.



R. S. BROWN.

Mr. James A. Trainor has been appointed assistant general sales manager of the American Flexible Belt Co. with offices at 50 Church street, New York. Mr. Trainor started his business life with the Baldwin Locomotive Works and worked his way up through various departments to the position of assistant to the sales manager. While with this company he gained a wide experience in locomotive construction and operation. In November, 1917, he entered the services of the U. S. Government as a Major in the Russian Railway Service Corps, this organization being sent to Russia to operate the Trans-Siberian Railway. Owing to the upheaval in Russia part of this organization was recalled to the U. S., and Mr. Trainor again entered the service of the Baldwin Locomotive Works, resuming his position as assistant to sales manager, which position he held at the time of his recent appointment.

BUY LIBERTY BONDS

Back Pay

Hundreds of thousands of employees in the railroad service of the United States have received or will receive checks for back pay, in accordance with order issued on July 25, 1918. No employee can make better use of his back pay than to lend it to the government at interest, thus helping to win the war, and securing an investment of absolute safety for himself.

BUY LIBERTY BONDS

American Locomotive Company.

The annual report of the American Locomotive Company shows that all of the company's plants have been engaged exclusively on locomotive production since October last year. Extensive additions have been made to existing plants, and the company purchased the former plant of the Kline Motor Car Corporation of Richmond, Va., and this plant is now used for the manufacture of the smaller accessories of the locomotive. The company disposed of the plants at Providence, R. I., formerly used for the manufacture of automobiles, and the locomotive plant at Manchester, N. H. Eight hundred locomotives of the administration's standard designs are now in course of construction and the company's plants are taxed to their utmost, and will likely continue to be so even after the war, as the scarcity of skilled labor as well as the shortage of material conduces to the unavoidable delays which, under existing conditions, should be expected.

Safety and Loyalty.

Not long ago Mr. Marcus A. Dow, General Safety Agent on the N. Y. C. lines, said among other things at a meeting held in Indianapolis, Ind., that the killing of 22,000 and the injuring seriously of half a million industrial workers a year in all classes of industry was a serious drain on the man-power of the nation, at a time when every available man is needed for the work that has to be done. We must keep the machines going, keep the wheels moving, keep the railroads and industries up to their highest point of productive efficiency. But we must keep as far as possible from having accidents or anything else that will tend to lessen that efficiency.

Safety effort and loyalty to the Government go hand in hand. Safety today involves a bigger thing than only industrial safety. It involves the safety of all and the safety of our country. Every American must be a good safety man. He must put his shoulder to the wheel, must give a full day's work every working day, and do nothing that will in any degree impair his ability, or the ability of others, to give that full measure of service. The railroads must be operated with the utmost efficiency. Good service and a full day's service every day on the part of every employe is necessary to that end. For an employe to lay off work, even temporarily merely to suit his own personal ends, deprives the country unnecessarily of services that are needed, and whether intended so or not is an act of disloyalty. Careless work, shiftless work, indifferent work, "Don't-give-a-hang" sort of work on the part of any man today is disloyalty to the country because it handicaps our boys "over there" in their effort to win the war.

BUY LIBERTY BONDS

Mixing Locomotive Coal for Economy.

The Lehigh Valley, of which Mr. F. N. Hibbits is superintendent of motive power, has adopted an ingenious method of mixing bituminqus and very fine, otherwise unusable, anthracite coal, so as to form a very satisfactory kind of fuel. The fuel mixing plant is at Hazleton, Pa., where the bituminous and fine anthracite coal is mixed for use on locomotives.

The bituminous coal is run through a set of breakers or rolls and broken into a small size, but not pulverized. The bituminous coal is then mixed in proportion to 60 per cent bituminous and 40 per cent fine anthracite coal known as silt, which is the waste anthracite almost as fine as powder. The bituminous coal cokes and holds the silt so that it is retained in the fire-box and not carried through the flues by the strong draft.

BUY LIBERTY BONDS

A man who won't lend is the Kaiser's friend.

Bituminous Zone System.

The United States Fuel Administration, cooperating with the Director General of Railroads, announced in March, 1918, that a zone system was to cover the distribution of bituminous coal during the coal year beginning April 1, 1918. To avoid waste of transportation is the purpose of the system. The system provides for the retention of something like 5,000,000 tons of coal for the East which has heretofore gone west. It will eliminate the movement of more than 2,000,000 tons of Pocahontas coal to Chicago and other western points over a haul of about 660 miles. Chicago can make up this shortage from southern Illinois mines, with an average rail haul of 312 miles. Thus, there will be saved 11,400,000 car-miles. This will permit 14 additional round trips of 20 days each from West Virginia to zone destinations, permitting an additional production of at least 700,000 tons of Pocahontas and New River coal.

BUY LIBERTY BONDS

Cleaning Coal.

Authority was given to the district representatives of the Fuel Administration to appoint inspectors of knowledge and experience to inspect the product of the various mines, and with sufficient authority to enforce the cleaning of coal at the mines. They were empowered to order the suspension of operation in mines where the coal was found naturally to be of such character as to be unfit for use. The order did not change the terms, conditions or validity of existing contracts, but new contracts were made subject to it.

BUY LIBERTY BONDS

Change of Tune.

The coal areas of France recently captured from the Huns will be the field of service for 300 steel coal cars being shipped from here. The cars were built by the Orenstein-Arthur Koppel Company for shipment to Germany by way of Mexico. The Orenstein-Arthur Koppel Company's plant near Pittsburgh was sold at auction by the alien enemy property custodian to the Pressed Steel Car Company, which will build 2,000 cars for the Allies.

BUY LIBERTY BONDS

Handling Material and Supplies.

One of the most frequent causes of injury to employes is the handling of freight or material and supplies. The records indicate that many of the injuries received by employes while engaged in work of this character are painful and cause long periods of lay-off from work. In almost every case the accident is one which can only be avoided by greater care by the workman himself or by closer supervision on the part of men in charge.

BUY LIBERTY BONDS

A bond slacker is the Kaiser's backer.

Railroad Equipment Notes

The Santa Fe has plans for the construction of a power plant 100 by 100 ft. at Shopton, Ill.

The Pennsylvania Lines have let contracts for a roundhouse and other terminal facilities at Canton, O.

The Tientsin Pukow Railway, China, has ordered 10 Mikado locomotives from the American Locomotive Company.

The Philadelphia & Reading has awarded a contract for the erection of a 70 by 200-foot engine house at Essington, Pa.

The new machine shop and engine house to be constructed by the Illinois Central, at Benton, Ill., is estimated to cost about $30,000.

The Pekin Kalgan Railway, China, has ordered 5 Mikado and three Mallet locomotives from the American Locomotive Company.

The Mississippi Eastern is having built at the Long Bell Lumber Company's plant at Quitman, Miss., 50 flat, box and logging cars.

The Chicago & North Western has let the contract for a seven-stall roundhouse at Beula, Ill., also for a mechanical coaling station.

The Lake Erie & Western has let contracts for a 20-stall roundhouse and an oil house at Lima, O., also a 10-stall roundhouse at Peru, Ind.

The Minneapolis, St. Paul & Sault Ste. Marie has ordered 50 hard coal car heaters from the Refrigerator Heater & Ventilator Car Company, St. Paul, Minn.

The American Locomotive Company has let a contract to the Lackawanna Bridge Company, Buffalo, for the erection of an addition to the boiler shop, to cost $150,000.

The Baltimore & Ohio is contemplating an expenditure of $168,000 for the enlarging and improving of its shops at Sandusky, Ohio, under government supervision.

The Chicago, Rock Island & Pacific will expend about $150,000 for improvements to be made at Herington, Kan., including an 18-stall addition to No. 2 roundhouse.

The Chicago Great Western has awarded a contract to the Ogle Construction Co. for the construction of a coaling station at Rochester, Minn., at an estimated cost of $10,000.

The Illinois Central has plans for the extensive new terminal facilities at Central City., Ky., including a 12-stall roundhouse, turntable, powerhouse, repair shop, conveyor pits, etc.

The Chicago & North Western has let a contract for the Ogle Construction Company for the construction of a coaling station at Rochester, Minn., at an estimated cost of $10,000.

Contract has been awarded to T. S. Leake & Company, Chicago, by the Illinois Central for the erection of a new engine terminal at Hawthorne, Ill., to cost $150,000, including engine house, machine shop, etc.

The Baltimore & Ohio has let a contract to the Surety Engineering Company, New York, to build an addition to its coal-thawing plant, at Curtis Bay, Md. The building will be one story of reinforced concrete and steel construction.

The Michigan Central has awarded contract to the Walbridge-Aldinger Company, Detroit, for construction of a boiler and tank shop for the repair of locomotives at Jackson, Mich., to be of brick and steel, 215 x 270 feet, estimated to cost $355,000.

The Baltimore & Ohio will establish a reclamation plant (adjoining $1,200,000 erecting shop now under construction) to handle materials from all the Baltimore & Ohio system; reclaim and distribute locomotives, cars, bridges, machinery, etc., at Cumberland, Md.

The Chesapeake & Ohio has let a contract to the Arnold Company, Chicago, to erect a brass foundry, 53 by 244 feet, costing $50,000; locomotive shop, steel frame, concrete foundations, 110 by 400 feet, cost $250,000; machine shop, main building of brick, 43 by 204 feet, concrete foundation, with leantos, sheds, etc., cost $100,000, and a general mechanical shop, power house and office annex building, at Richmond, Va.

Roberts & Schaefer Co., Chicago, were recently awarded a contract by the Philadelphia, Baltimore & Washington for the designing and construction of a 300-ton capacity two-track automatic electric locomotive coaling plant and a concrete "RandS" gravity sand plant, using Beamer patent steam sand dryers, for erection at Perryville, Md. The Pennsylvania awarded the same company a contract for the construction of a 900-ton capacity two-track reinforced concrete automatic electric locomotive coaling plant and a "RandS" gravity sand plant for installation at Youngswood, Pa. Contract price was $135,000.

Books, Bulletins, Catalogues, Etc.

Fuel Conservation

Eugene McAuliffe, manager, Fuel Conservation Section, United States Railroad Administration, has issued a special circular No. 13, calling upon the chief operating officer of each railroad to direct the attention of every employee who is connected with the maintenance and operation of brake equipment to the observance of the recommendations submitted by a committee of the Air Brake Association, and which were published in the September issue of RAILWAY AND LOCOMOTIVE ENGINEERING. It is requested that a copy of the circular should be posted on all bulletin boards, and a copy should be furnished to men in charge of repair yards, to yardmasters and to conductors for posting in train cabooses. The recommendations are largely based on the necessity for a stricter inspection, and better care of air brake equipment, particularly with a view to amend the causes of brake-pipe leakage, which it is claimed by the Air Brake Committee, is responsible for an annual loss of 6,000,000 tons of coal.

BUY LIBERTY BONDS

Graphite.

Dixon's Silica-Graphite Paint is the text of the latest issue of *Graphite*. Tank cars run over five years without repainting when Dixon's silica-graphite paint is used. Other paints last less than three years. On wooden buildings it is good for fifteen years, while other paints evaporate or fall off in less than five years. It is not only the coming paint, but it is the staying paint. It lasts longer, and hence reduces the cost by reason of its durability. It defies climatic influences. The expanding city of Buenos Aires has its principal structures covered with it. Those who desire to see copies of testimonials should send for a copy of Vol. XX. No. 8, to the Joseph Dixon Crucible Co., Jersey City, N. J.

BUY LIBERTY BONDS

Staybolts

The bi-monthly Digest, issued by the Flannery Bolt Company, Pittsburgh, Pa., has the rare quality of singleness of purpose. It sticks to staybolts, and does not wander off into realms of thought or endeavor with which it has no concern. It does not even remind us that war stamps are on sale. In the latest issue it tells us how the first completed United States standard locomotive is one of 1,415 of the light Mikado type that will be completed this year. While pointing out the merits of the flexible stay bolt it reminds us that they were first thought of a quarter of a century ago, as the most practical means to overcome the effects of a too rigid assemblage in the firebox connections of the locomotive boiler. This conception prevailed when firebox dimensions were very small compared to present day designs, yet the idea brought to light a principle that was quite generally disregarded, and largely ignored, in the sense of defining its application and true value, which to all intents and purposes is most vital when full consideration is given to the best methods, and the provisions necessary to properly stay and safeguard the material structure of the firebox assemblage, under the stress and influence of the variable firebox temperatures existing under service conditions.

BUY LIBERTY BONDS

Classifications of Coal

The Geological Survey gives to coal six classifications. They are: Anthracite, semi-anthracite, semi-bituminous, bituminous, sub-bituminous, and lignite. All of these various classes are produced in the United States. Most of the anthracite coal is mined in eastern Pennsylvania. Small areas of coal exist in the West that are placed in the anthracite classification, but which are not identical in quality with the Pennsylvania anthracite. Anthracite is an almost ideal domestic fuel, but is not well adapted to steam raising, although it is used for this purpose when an absolutely smokeless fuel is required.

There is very little semi-anthracite in this country, hence is but a small factor in the trade. Semi-bituminous is of higher rank than bituminous. It has a high percentage of fixed carbon, which makes it nearly smokeless. It is best adapted to raising steam and to general manufacture that requires a high degree of heat. It is regarded as the best coal for steamships, and is used almost exclusively by the Navy. Being of a soft, tender quality, it is easily broken. This fineness is regarded by those accustomed to lump coal as detrimental, but it is not. It burns slowly and retains a high degree of heat.

Bituminous coal is produced in a number of grades, but generally speaking it describes a grade of coal having about equal proportions of volatile matter and fixed carbon. Bituminous coal is only slightly affected chemically by weathering unless it is exposed for many years.

"Sub-bituminous" is a term adopted by the Geological Survey to describe a grade of coal more generally known as "black lignite." It is produced principally in the Western States. It is a clean, domestic coal, and ignites easily.

Lignite is a product of North Dakota and Texas. It is heavy in moisture when it comes from the mines, but dries quickly when exposed to the weather. Lignite is marketed mainly at points near the mine as a domestic fuel.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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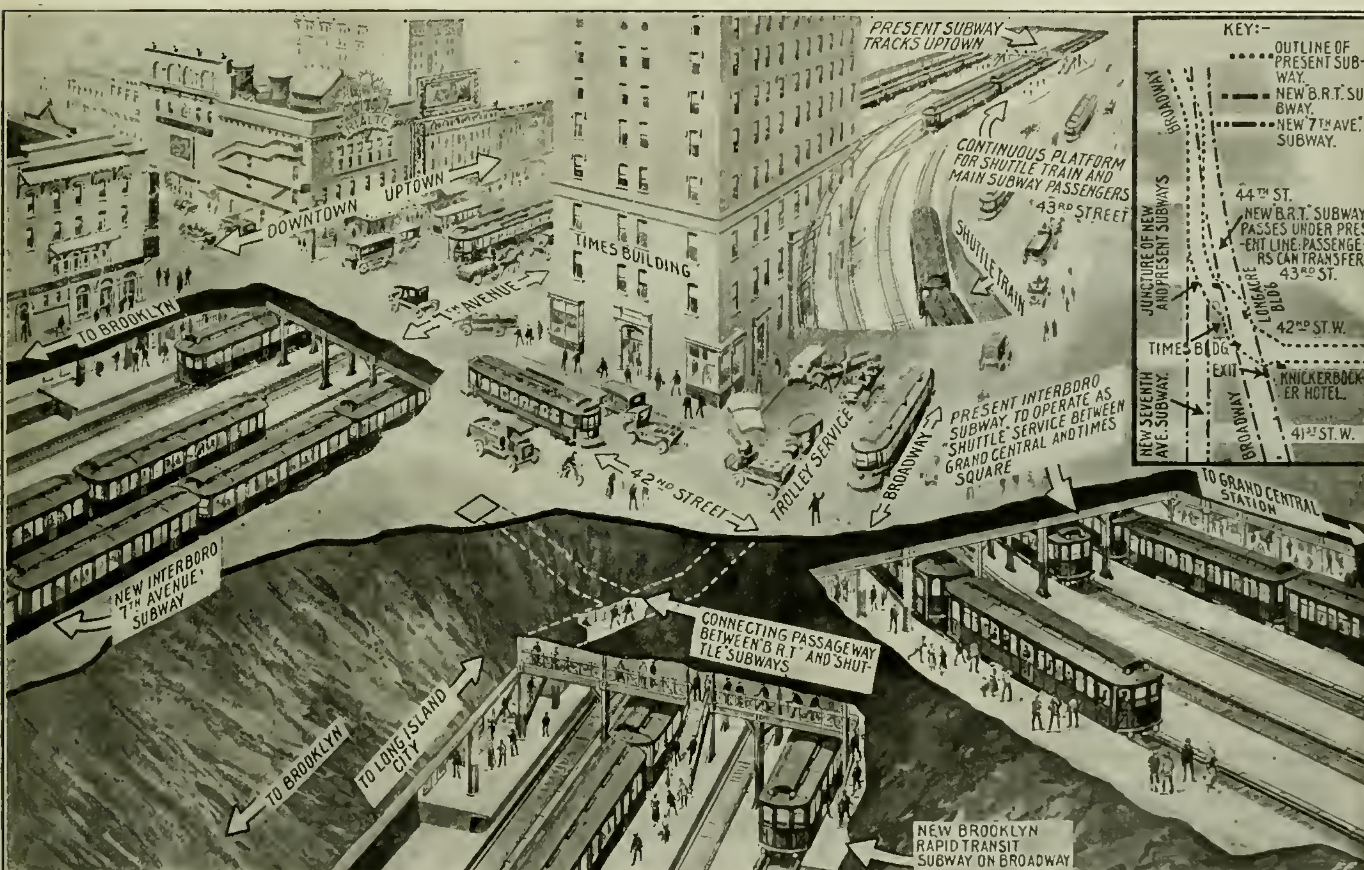
Completion of the New York Subway Extension

Since the recent completion of extensions and improvements it may be truthfully said that the New York subway extension system represents the world's greatest achievement in electric railway construction. It consists of 619 miles of track, serves four of the five boroughs of the city and has a capacity of three billion passengers per annum. New York, after five years of construction work and the expenditure of $400,000,000, or more than the cost of the Panama Canal, has completed and has put into operation the greater part of her new system of rapid transit known as the Dual System because of the Interborough Rapid Transit Company, and the Brooklyn Rapid Transit Company have co-operated with the city in developing it.

Four parallel elevated lines and a subway constituted the former rapid transit system in Manhattan. The subway started in Brooklyn, ran north through the eastern part of Manhattan as far as 42nd street, west on 42nd street to Broadway, and then north through the western part of the city, thus forming the so-called "Z." In the new system the eastern part of the old subway has been continued south thus forming two parallel and independent subways with a shuttle connection under 42nd street. This arrangement is known as the "H." The eastern branch uses the old Brooklyn tunnel, while the western will later on enter Brooklyn through a new tunnel. These two subways are operated by the Interborough Rapid Transit Company. A third subway is operated by the New York Municipal Railway Corporation formed by the Brooklyn Rapid Transit Company. This subway was built between two Interborough subways, which will eventually start in Brooklyn pass under Broadway, Manhattan and run over the Queensborough Bridge, at 59th street into Queens County. A fourth subway operated by the Interborough, connects with the old subway at the Grand Central Station and runs through the Steinway tube to Long Island City thence into Queens Borough.



NEW YORK SUBWAY CONNECTIONS, TIMES SQUARE, 42D STREET, NEW YORK.

Courtesy Electrical Experimenter.

Thus the railway mileage of New York City has been more than doubled and it has the most extensive subway system in the world, comprising as it does more than two hundred miles of underground railway. Some of the subway routes which honeycomb the soil of the great Metropolis has necessitated the boring of tubes under the East river, at an enormous cost, and under difficulties, which would seem to require almost superhuman endeavor, and patience and skill.

In addition to this great work a third track has been added to the elevated railways on which express service is provided during the rush hours, while instead of one subway there are now three with express service all day. Hence it is no exaggeration to say that the transportation facilities have been increased five fold in down-town Manhattan and three fold elsewhere.

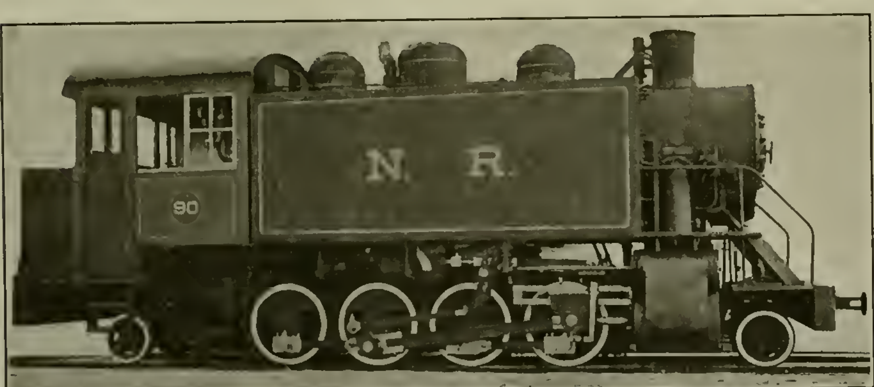
A large amount of new equipment was naturally needed for the Dual System and for this the Westinghouse Electric & Manufacturing Company has furnished 600 control equipments for the New York Municipal railways and 680 control equipments and 978 Matroes for the Interborough lines, the total cost of this apparatus being over $3,000,000. The power requirements are also greatly increased and to supplement its present power equipment, the Interborough Company has installed an 80,000 horsepower Westinghouse turbine generator, which helps considerably.

Tank Engine for Chile, South America

The H. K. Porter Company of Pittsburgh, Pa., have recently constructed four tank engines of the 2-8-2 type for the Nitrate Company of Chile, S. A. These engines are to run on a 56½-inch track, which is of course our standard gauge in the U. S. The cylinders are 22x20 ins. The driving wheels, of which there are eight, are 47 ins. in diameter. The total engine weighs 180,000 lbs. and of this 146,000 lbs. are on the drivers. The leading pony truck carries a weight of 16,000 lbs. and the rear wheels bear 18,000 lbs. The rigid wheel base measures 12 ft., and the total wheel base in 27 ft. 6 ins.

The weights so distributed as stated, with a factor of adhesion of 4.02, the tractive power is calculated at 36,240 lbs., the height of this engine for clearance, is 14 feet., its width is 10 ft., 10 ins., and the length over the bumpers is 34 ft. The boiler is of the straight type, 66 ins., in diameter at the largest ring, and maintains a steam pressure of 185 lbs. per sq. in. The fire box is 84 ins., long, 57 ins. wide at the top, and 52 ins. at the bottom. The boiler is supplied with a type "A" superheater, double loop style, made up of 22 units. The arrangement of the tubes gives 155 of 2 ins. diameter and 22 flues 5⅜ ins. diameter. The length of the tubes is 12 ft.

In the matter of heating surface the tubes give 967 sq. ft., the flues give 369 sq. ft., and the fire box measures up to 130 sq. ft. The total, with the superheater, as given at 288 sq. ft., comes up to 1754 sq. ft. The grate area is 30.3 sq. ft. The fuel is oil and the tank holds 1,000 gals., of it. The water supply amounts to 3,000 U. S. gals. This boiler is made of open hearth steel, thoroughly braced and stayed. Brass wash-out plugs are supplied and the holes for the plugs are expanded so as to give sufficient thickness for an ample number of threads. The cylindrical sheets are ⅝ in. thick, the back head is 9-16 in. thick, the tube and throat sheets are ⅝ in. The horizontal seams are butt-jointed, sextuple riveted, with inside and outside welts. The dome is 32 ins. in diameter, and 26 ins. high. A fusible plug is used in the crown sheet.



2-8-2 TYPE ENGINE FOR THE NITRATE COMPANY OF CHILE, S. A.
Built by the H. K. Porter Co. of Pittsburgh, Pa.

The water spaces at the fire box sides, back and front are 4 ins. The crown sheet is ⅜ in. thick, as are also the side sheets. The tube sheet is, however, ½ in., thick. Tell-tale holes are drilled, to a depth of 3-16 in. in diameter, in the outer ends of the stay bolts. The radial stays are one inch in diameter, 4¼ ins., centre to centre. The central rows are made with button heads under the crown sheet. There is an extended front with low exhaust and lift pipe. The two injectors supplied are Sellers, 9½ type "N." These injectors have stop valves, so that injector checks can be removed and examined with boiler under full steam.

The cylinders which are 20x22 ins., as we have already said, are oiled, as are other appliances, by a Detroit Bull's Eye, No. 42, five-feed automatic sight feed lubricator. The valves are piston valves, and metallic packing is used for the piston rods and fibrous packing for the valve stems. The cross heads are steel with brass bearings, and are of the Laird type. The main driving wheel centres are made of cast steel, the others are composed also of cast steel turned to 36 ins. diameter, upon which the open hearth tires 3 ins. thick and 5½ ins. wide, are shrunk on, All tires are flanged and held, in addition to the shrunk-fit, by set screws. The main journals are 8⅝ ins. in diameter, by 9½ ins. long. The other journals are 8x8⅝ ins. The driving boxes are steel, with babbitted faces. The rods are fitted with straps, keys, and brasses.

The engine has a radial truck front and rear, and the front truck is equalized with the drivers. The truck frames are of cast steel with 26-in. wheels and 2x5-in. tires. The axles are hammered open hearth steel with journals 5 13-16x9 ins. The cab of the engine is made of sheet steel, with a ventilator in the roof. The tank is placed at each side of the boiler, with a connecting pipe between. As oil is the fuel, the engine has a No. 3 Best oil burning apparatus, with steam pipe in the oil tank and a steam jacket for the oil pipe leading to the burner. The oil burner is placed under the fire box tube sheet, and the fuel is carried at the rear. There is a steam brake on all the driving wheels, with hand screw attachment, and the Le Chatelier brake has also been applied.

The builders do not confine their activities to the building of light locomotives. They also construct engines of any size and weight which may use steam or compressed air, and they also build what sounds like a contradiction in terms, the fireless steam locomotive which has come into service in the vicinity of factories and works where it would not be in keeping with the principle of "safety first" to employ fuel-burning steam locomotives.

Virginian Mallet Locomotives

Ten Mallet locomotives having a tractive power of 147,200 lbs., working compound, and 176,600 lbs., working simple, are now being delivered to the Virginian Railway by the American Locomotive Company. This order was given because the authorities of the Virginian Railway had the problem of handling a constantly increasing volume of traffic on an exceptionally difficult part of the system, steadily before them.

The portion of the line between Elmore and Clark's Gap on the Deepwater division, a distance of about fourteen miles, has a grade for the last eleven and one-half miles of 2.07 per cent with maximum compensated curves of 12 degs. For the first two and one-half miles the grade is 0.5 per cent. This fourteen miles is all single track and includes five tunnels, which compel the use of an absolute block system. This is the crucial part of the entire system, as all the tonnage of the Virginian Railway passes over it. During the last eleven years, Mallet locomotives have been employed in handling this traffic. The size and power of these locomotives have progressively advanced to keep as it is not desired to increase the number of engines on any train above three, it has been found necessary to put still larger locomotives into service. The enormous locomotives here described were developed in order to accomplish this result.

Upon receipt of these new engines, trains will be composed of one of the 2-8-8-2 Mallet engines, having a tractive power of 115,000 lbs., at the head, and two of the new 2-10-10-2 Mallet engines, having a tractive power of 147,200 lbs., behind, giving a total tractive power for the train of 409,400 lbs. The train to be hauled by this combination of engines will have a tonnage of 5,850 tons, the equivalent of 78 cars having an average weight for car and load of 75 tons.

The 2-8-8-2 type Mallets which will be used on the head end of the train were built by the American Locomotive Company in 1912 and 1913. At that time these engines were the most powerful locomotives in the world. The following comparison shows the extent to which these 2-8-8-2 type engines have been exceeded in the new 2-10-10-2 type locomotive:

surface of 2,120 sq. ft. are obtained. The design as a whole follows the builder's ordinary practice, differing from previous designs only in modifications made necessary by the increase of power.

These engines were built at Schenectady, N. Y., and the contract called for delivery completely erected and ready for service on the Virginian Railway Company's tracks. The shipping arrangement required considerable planning before the railroad carriers could be convinced that they could safely accept, and run over their lines, locomotives of such size and weight.

In preparing for the shipment of large locomotives it is first necessary to submit diagrams showing the estimated height and width, clearance dimensions, and the distribution of weights on each axle to the operating or engineering departments of each carrier over whose line it is intended to route the shipment, in order to secure the agreement of the railways to handle the shipment when offered to their lines. If some projection exceeds the carriers' clearance limitations, an effort is made to meet the objection by removing

HEAVY MALLET LOCOMOTIVE FOR THE VIRGINIAN RAILWAY.
R. E. Jackson, Supt. of Motive Power. American Loco. Co., Builders.

pace with the growth of the traffic.

The first installment consisted of four engines of the 2-6-6-0 type with tractive power of 70,800 lbs. Next in sequence were eight of the same wheel arrangement but with a tractive power of 90,000 lbs. The third installment consisted of one engine of the 2-8-8-2 type with a tractive power of 100,800 lbs. The fourth lot was six engines of the 2-8-8-2 type with a tractive power of 115,000 lbs.

At present, trains passing over the mountain section are operated by one 2-6-6-0 type Mallet road engine, with a tractive power of 90,000 lbs., at the head, and two 2-8-8-2 Mallet pusher engines, with a tractive power of 115,000 lbs. each, behind. The maximum tractive power which can thus be applied to a train is 320,000 lbs., which enables them to handle 4,500 tons in 60 cars having an average weight for car and load of 75 tons.

The traffic volume on this road is still growing, and as the track is single, and

Apart from the enormous weight and power of the locomotive as a whole, some of the dimensions of the boiler are impressive as showing the extent by which all limits were exceeded in its design and construction. At the first course it is

that part, if possible, and reapplying it on arrival at destination. Or, if the weights are too heavy for some trestle or some bridges via a natural route, an effort was made to find a way to ship by a detour route.

	2-8-8-2 Type	2-10-10-2 Type	Per Cent Increase
Total weight of engine, lbs..............	540,000	684,000	26.6
Total weight, engine and tender, lbs.....	6,909	8,606	24.5
Heating surface, sq. ft..................	1,311	2,120	61.7
Superheating surface, sq. ft.............	115,000	147,200	28
Tractive power, compound, lbs...........	138,000	176,600	28
Tractive power, simple, lbs..............	752,000	898,300	19.5

105½ ins. in diameter, outside, while the outside diameter of the largest course is 112⅞ ins. The barrel is fitted with 381 tubes 2¼ ins. in diameter, and 70 flues, 5½ ins. in diameter and 25 feet long. A combustion chamber 36 ins. long is included. The firebox is 181 1/16 ins. long and 108¼ ins. wide. A total heating surface of 8,605 sq. ft. and a superheating

These large locomotives presented an unusual problem. It was impossible to ship them completely assembled and moving dead on their own wheels. After the consideration of many plans, it was finally decided to leave the boiler on the frames but trimmed of all outside parts and projections. The cab, low-pressure cylinders, and other certain parts were removed and

the remaining skeleton with tender were shipped on their own wheels. Each locomotive required one flat, one gondola, and one box car to carry the loose and detached parts. Authority was eventually secured for shipping in this manner, although under special operating instructions and via detour routes. The full route used was as follows:

New York Central Railroad, Schenectady to Newberry Junction. Pennsylvania Railroad via Columbia, Perryville, Newark, Delaware, Porter, Delmar and Cape Charles. Float from Cape Charles to Port Norfolk, Va. N. & P. B. L. Ry., Norfolk & Western, and Virginian Railway to Princeton, W. Va.

The Norfolk & Western Railway was used only in the Norfolk district as the Norfolk & Portsmouth Belt Line Railway could not handle these engines direct to their point of connection with the Virginian Railway. These engines could only be handled one at a time from Cape Charles to Norfolk as there was only one float, the latest one built, capable of handling the shipment under special instructions. Each locomotive was accompanied by a messenger who had sleeping quarters fitted up in the cab, which was loaded on a flat car. Approximately two weeks has been the actual running time from Schenectady, N. Y., to Princeton, W. Va.

Track gauge, 4 ft. 8½ ins. Fuel, bituminous coal. Cylinder, type, h. p. piston valve; diam., 30 ins.; l. p. slide valve; diam., 48 ins.; stroke, 32 ins. Tractive power, simple, 176,600 lbs.; compound, 147,200 lbs. Factor of adhesion, simple, 3.49; compound, 4.19. Wheel base, driving, 19 ft. 10 ins. and 19 ft. 10 ins.; rigid, 19 ft. 10 ins. and 19 ft. 10 ins.; total, 64 ft. 3 ins. Wheel base, total, engine and tender, 97 ft. Weight in working order, 684,000 lbs.; on drivers, 617,000 lbs. Weight on trailer, 35,000 lbs.; on engine truck, 32,000 lbs. Weight, engine and tender, 898,300 lbs. Bailer, type, ext. wagon top; O. D., first ring, 105½ ins. Boiler, working pressure, 215 lbs. Firebox, type, wide; length, 181 1/16 ins.; width, 108¼ ins. Firebox grate, length, 144⅝ ins.; width, 108¼ ins. Firebox combustion chamber, length, 36 ft. O. 3/16 ins. Firebox, thickness of crown, ⅜ in.; tube, ⅜ in.; sides, ⅜ in.; back, ⅜ in. Firebox, water space front, 5½ ins.; sides, 5 ins.; back, 5 ins. Firebox depth (top of grate to center of lowest tube), 9 ins. Crown staying, 1 1/16 in. radial. Tubes, material, hot rolled seamless steel; Number 381; diam., 2¼ ins. Flues, cold drawn seamless steel; Number 70; diam., 5½ ins. Thickness tubes, No. 11; flues, No. 9. Tube, length, 25 ft.; spacing, ⅞ in. Heating surface, tubes and flues, 8,090 sq. ft.; firebox, 437.5 sq. ft.; arch tubes, 78.5 sq. ft.; total, 8,606 sq. ft. Superheater surface, 2,120 sq. ft. Grate area, 108.7 sq. ft. Wheels, driv., dia. outside tire, 56 ins.; center diam., 49 ins. Wheels, driv., material, cast steel. Wheels, engine truck, diam., 30 ins.; kind, rolled steel. Wheels, trailing truck, diam., 30 ins.; rolled steel. Wheels, tender truck, diam., 33 ins. Axles, driv. journals, main, 12 x 15 ins.; other, 11 x 13 ins. Axles, engine and trailing truck journals, 6½ x 13 ins. Axles, tender truck journals, 6 x 11 ins. Boxes, driving, all cast steel. Brake, driver, American; truck, cast steel. Brake, trailers, American. Brake, tender, Westinghouse; air signal, W. A. B. Brake pump, two 8½-in. W. A. B. cross compound; reservoir, two 20½ x 90 ins.; one, 20½ x 144 ins. Exhaust pipe, double; nozzles, 6½ ins. Grate, style, rocking. Piston, rod diam., 4¾ ins.; piston packing, snap rings. Smoke stack, diam., 22½ ins.; top above rail, 16 ft. 7½ ins. Tender frame, cast steel. Tank, style, water bottom; capacity, 13,000 gals.; fuel, 12 tons. Valves, h. p. 16-in. piston; travel, 6½ ins.; steam lap, 1 in. Valves, l. p. slide; travel, 6 ins.; steam lap, 1⅛ ins. Valves, ex. lap, clearance, h. p., ¼ in.; l. p., 9/16 in. Valves, setting, lead, h. p., ⅛ in.; l. p., 3/16 ins. These engines are beyond doubt the heaviest locomotives in the world, and require strong bridges and track.

Norfolk & Western Large Capacity Wooden Hopper Car

The Norfolk & Western have lately built at their own shops 2,000 cars for the carriage of coal principally, but ore and rough freight can be handled by them as well as coal. The salient feature about these cars is that they have no roofs, and the doors for the egress of the load are in the bottom and are approached by the coal through hopper slides. The cars look as if they were box cars, but are loaded from above, so that there being no roof, each car can be filled full and carry a very heavy load.

The cars are designed so that all but 10 have steel centre sills and bolsters, and these 10 have been made entirely of wood. These few cars have been built with a view of testing the value of the idea, that cars of large capacity (115,000 lbs.) could be built of wood. With the exception of the draw gear, bolsters and centre sills, both kinds of cars are exactly alike. The all-wood cars have centre sills 6 x 12 ins. spaced 15½ ins. apart. The bolsters are made of two 16 x 20 ins. timbers, 4½ ins. apart and put over the centre sills, at a distance of 4½ ins. from each other. The bolster-timbers are fastened to the sills by a centre casting, which acts also as a centre plate and forms a filling piece between the bolster-timbers and the centre sills. Other attachments in the form of cast iron brackets tie these members together.

The draw gear (Sessions) is secured to the centre sills. The centre line of the draw gear is 4 1/16 ins. above the lower face of the sills. The pull is transferred to the cheek castings by the follower plate. Each cheek casting has four vertical projections or keys cast in them, and these fit tightly into cross cut spaces or pockets, in the sills, so that they take part of the pulling and buffing stresses from the cheek bolts. The coupled shank is 28 ins. long, so as to carry the front cheek castings back as far as possible. In buffing the end of the coupler yoke bears directly against an extension from the centre casting, so that in reality the cheek castings are subjected to severe strains in one direction only. Buffng sills 4 x 8 ins. are placed between the centre sills, and the ends of these members are fitted into pockets in the back of the centre plates, so that buffing strains go through the centre casting to the end of the buffing sills, and no sheering stress is imposed on the casting bolts by which the casting is held to the centre sills.

The end sills are 4½ x 12 ins., and are placed immediately above the centre sills, and are bolted to them. The ends of the centre sills, by this means, gain a support from the side frames of the car. They also receive support from the hopper end, by posts 4½ x 4½ ins. positioned in the outer angles which are between the centre and end sills. The ends of the centre sills are capped and tied together by a casting of malleable iron, to which the carrier iron and the dead wood are attached. This dead wood is 8 x 4 ins. in section and is faced with a steel plate 1¼ ins. thick. The carrier iron is made of a 5 x 3½ x 7/16 ins. angle, and is 27⅛ ins. long, with horizontal flange turned up, so as do duty as the coupler limit stop.

The form decided upon for the car bodies is that of the king post side truss,

which form a brace for the side sills and so helps in the carriage of the load. The trusses have 4½ x 9 ins. side sills and 4½ x 4½ ins. plates. There are three 4½ x 4½ ins. posts; two are at the bolsters and the other at the centre, forming the king post. Main diagonal members, 8 x 4½ ins., extend from the top of the king post to footings at the bolsters, where a large pocket casting receives the lower ends, the keys for which are cast integral with the pocket and the key ways are gained in the wood. The tension members are two ⅞-in rods. V-shaped bolts straddle the frame and are secured to the sills. They are supported from the main diagonals by the ⅞-in. tension rods. The truss is held in place by 4½ x 4½ ins. compression members which support the main diagonals. The doors is taken by the side sills. The centre sills thus, are seen to uphold a quarter of the door-load, and part of this is transmitted by the needle beams and bolsters to the side frames. The siding and chutes, being wood, are ship lapped and are 1 5/16 ins. thick. The siding is vertical and is spiked to the side frames with support boards bolted in place. On the inside of the car horizontal retaining strips are attached to the sides in order to prevent the boards becoming loose by the pounding or hammering of the car by men, to loosen pieces of coal which adhere after unloading.

The chute boards are supported at the ends and over the bolsters, but in addition they have two intermediate supports secured to the side planking by cast iron pockets. The lower one is gained over ing dimensions are as follows. Length inside, 33 ft. 4⅞ ins. Coupled length, 37 ft. 1 in. Distance between truck centres, 23 ft. 6½ ins. Inside width, 9 ft. 2¼ ins. Width to clear, 10 ft. 4 ins. Top of sides above the rail, 10 ft. 9½ ins. Capacity, 57½ tons. Light weight 42,300 lbs. Cubic capacity (level full) 1,980 cu. ft. Cubic capacity (30 degs. heap) 2,350 cu. ft. U. S. Safety Appliances Standard. K-2 triple W. A. B.

Inspector of Car Equipment.

An open competitive examination for senior inspector of car equipment open to all male citizens of the United States will be held in the districts established by the Interstate Commerce Commission. The entrance salaries range from $1,800 to $3,600 a year. Applicants must have reached their twenty-fifth but not their sixtieth birthday. And all applications should be filed with the Civil Service Commission, Washington, D. C., on or before November 12, 1918.

NORFOLK & WESTERN COAL CAR BUILT ON ORIGINAL LINES.

overhang of the side frames at the ends is carried by ⅞-in. diagonal rods.

The car has four sets of double hopper doors, hinged from cross timbers, resting on the side and centre sills. The doors are 2 ft. 9 ins. in width and extend across the car. When the doors are shut they are supported at the ends only, but the edges of the doors are reinforced by angle irons. The ends of these angle irons project slightly beyond the sides of the car, where they engage with the hooks used in holding the doors closed. The locking device is simple and effective and is similar to that used on the Norfolk & Western 100-ton steel hopper coal cars. Across the car, and above the sills, two 4½ x 12 ins. needle beams are placed so that the load at the centre sills is partly transferred to the side frames.

At the doors, half the load is carried by the centre sills and half by the side sills. The load at the hinge-side of the the centre sills and the upper one is supported from the end sill by 6 x 4 ins. diagonal struts. Under the chutes are two truss rods passing from the top of the chute on one side to the bottom of the chute at the other side. The chute itself is practically a transverse truss in the centre of the car which helps to keep the side frames rigid and has the general effect of keeping the whole structure from getting out of alignment. The sides of the car are tied together at the top by five ⅞-in. rods, used as cross bolts.

The trucks are built up of cast steel frames and bolsters. The wheels are ordinary cast iron, 33 ins. diameter with a wheel base of 5 ft. 6 ins., and the axles present journals 5½ x 10 ins. The cars have so far given excellent results and no shrinkage of wood has been noticed though some of the all-wood cars have been in heavy service with steel cars for about eight months. Some of the lead-

Locomotive builders in the month of September turned out 480 locomotives, according to reports to the Railroad Administration. The locomotives delivered to the railroads under government control, amounted to 251, of which 151 were delivered by the American Locomotive Company, 78 by the Baldwin Locomotive Works and 22 by the Lima Locomotive Works. This brings the total number of locomotives delivered to the railroads under government control for the year to date to 1,951. In addition to those already mentioned, during September the builder shipped 16 miscellaneous locomotives and completed 213 foreign locomotives.

Official Reports on Recent Railway Accidents

Mr. W. P. Borland, Chief of the Bureau of Safety, Interstate Commerce Commission, has reported upon the collision which occurred on June 22, 1918, between two extra trains on the Michigan Central railroad at Ivanhoe, Ind., which resulted in the death of 67 passengers and one employee and the injury of 127 passengers. The investigation of this accident was made in conjunction with the Indiana Public Service Commission, and the hearing was held at Hammond, Ind.

Mr. Borland reports further on a collision that followed on July 9, 1918, between two passenger trains on the Nashville, Chattanooga & St. Louis Railway at Nashville, Tenn., which resulted in the death of 87 passengers and 14 employees, and the injury of 87 passengers and 14 employees. Two disasters of such magnitude occurring at such a short interval attracted wide attention, and the official reports have been awaited with much impatience, as the reports of recent years have revealed such a marked degree of safety as far as the list of accidents to passengers was concerned, that it is of vital interest to learn what the official report would be as showing how far mechanical defects might be considered as the cause, or how far negligence on the part of those engaged in operation was contributory.

The trains involved in the first accident referred to, were westbound extra 7826 with a part of the Hagenbach-Wallace Circus, en route from Michigan City, Ind., to the Indiana Harbor Belt railway at Gibson, Ind., and westbound extra 8485, an empty equipment train, en route from Detroit, Mich., to Chicago, Ill. The circus train left Michigan City at 2:30 a. m. with orders to take the Gary & Western at Ivanhoe. It proceeded at about 25 miles an hour, slowed up on account of the caution signal east of Ivanhoe, and was stopped on account of a hot box on the south side of the train which was observed by the flagman on the rear as the train approached Ivanhoe. The train stopped at 3:55 a. m. The flagman of the circus train immediately proceeded with the usual caution signals to guard the approach of an oncoming train. Extra 8485, consisting of 21 Pullman sleeping cars left Michigan city at 2:57 a. m. and passed the automatic signal two miles east of Ivanhoe, at caution; passed the next signal at stop; passed the flagman of the circus train at 3:57 a. m. The four sleeping cars on the rear of extra 7826 were entirely destroyed, and the wreckage immediately took fire.

From the evidence of the trainmen, all signals and equipment were in good condition, and every man alert at his post, except the engineman who in his evidence admitted that the accident was solely due to the fact that he had fallen asleep.

In summing up the Chief of the Bureau of Safety states that the collision is another example of that class of accidents which a modern system of signalling is powerless to prevent. The only way to guard against such accidents is the use of some form of automatic device which will assume control of the train when the engineman fails to obey the stop indication of a signal. It is in view of this fact that the automatic stop has been devised and appliances of this kind have now been sufficiently developed to warrant service trials on an extensive scale. Protection by flag cannot be relied upon if for any reason an engineman disregards a stop signal indication. The flagging rule can be relied upon to furnish but little if any additional protection. The automatic stop should be developed as has been the case with other signal devices It is the duty of railroads to surround their passengers with every known safeguard, even though some of the devices may be called upon to act very infrequently.

In the second case referred to this accident occurred on a single track line over which trains are operated by time table and train orders, there being no block system in use. Train No. 1 consisted of locomotivce 281 and eight cars partly wooden and partly of steel construction. It approached Nashville about 30 minutes late and collided with train No. 4 at a point about 4½ miles from Nashville, while both trains were running at a speed of about 50 miles an hour.

Train No. 4 consisted of locomotive 282, and eight cars all of wooden construction, and the dispatcher stated that when he issued the train order for train No. 4 to meet train No. 1, he added the information that train No. 1 was being hauled by locomotive 281, to aid them in identifying the train, and also to advise them as to whether or not the train had arrived at the shops where there are double tracks. He stated that trains No. 1 and 4 are scheduled to pass on the double track, between Nashville and the shops, and in case train No. 4 arrived at the shops before train No. 1, train No. 4 is expected to remain at the shops until train No. 1 arrived, unless the crew received authority to proceed, train No. 1 being the superior train. There was no train register at the shops. Both the engineer and conductor were advised that train No. 1 had not arrived at the shops, the dispatcher remarking that No. 1 was considerably late, but from the remarks passing between them, the dispatcher supposed that the engineman knew that the train was liable to be detained at the shops to meet train No. 1, it being the understanding that the interlocking signals gave train No. 4 no right over superior trains beyond the shops. In regard to this a special order had been issued on May 28, 1918, reading as follows:

Understand some engineers on outbound trains are passing the shops without any definite information as to whether superior trains have arrived, other than to ask operator at shop tower. This must be discontinued. Superior trains must either be registered before the northbound trains depart or be identified by some member of the crew of the superior train, and meet the superior train between Nashville and the shops or have an order at the shops stating that the superior train has arrived.

NOTE.—See that train dispatchers understand this and have the orders ready at the shops so they can be handed on to the outbound trains.

The accident was caused by train No. 4 occupying the main track on the time of a superior train, for which the engineman and conductor were responsible. Rule 83, provides in part as follows:

A train must not leave its initial station on any division, or a junction, or pass from double to single track, until it has been ascertained whether all trains due, which are superior or of the same class, have arrived or left.

It is to be noted that all the cars of both trains, except the two sleeping cars on train No. 1, were of wooden construction, and six of these wooden cars were entirely destroyed. This accident presents a more appalling record of deaths and injuries than any other accident investigated by the commission since the accident-investigation work was begun in 1912. Had steel cars been used in these trains, the toll of human lives taken in this accident would undoubtedly have been very much less.

The report further stated that this accident would have been prevented, beyond question of doubt, by a properly operated manual block system on the single track line north of shops, for which all necessary appliances and facilities were already available. The time table indicates that between Nashville and Hickman, Ky., a distance of approximately 172 miles, there are 27 train-order offices, of which 14 are continuously operated. On this line there are four scheduled passenger trains in each direction, and a total of 12 scheduled freight trains. With this volume of traffic, and in view of the universally recognized features of increased safety afforded by the block system, there can be no valid excuse for the failure or neglect on the part of the railroad company to utilize existing facilities for the purpose of operating a block system.

Experimenting With Peat Fuel

Peat, as found in its natural state, contains about 10 per cent. combustible matter and 90 per cent, water, the removal of this exceedingly high proportion of water constituted the great problem for the peat engineer. It is claimed that the water content of raw peat can not be reduced much below 80 per cent. by pressure alone, but the process of wet carbonizing has not proved a success. Any process depending upon the employment of artificial heat for the evaporation of the moisture will not prove economical. The only economical process in existence at the present time is that which utilizes the sun's heat and the wind for the removal of the moisture through a long period of time.

The only approach to progress that is being made towards the utilization of peat as a fuel in America is that attempted by the Peat Committee of Canada. Unfortunately this committee was appointed too late to be a factor in the coming winter's fuel supply for Ontario. Moreover, if the present limited plans are followed, this committee will not be a factor in the fuel supply for the winter of 1919-20. It will be the winter of 1920-21 before any considerable quantity of peat is on the market, and by that time public interest in the enterprise may be thoroughly chilled.

The Dominion government owns a large peat bog at Alfred, Ont., where exhaustive experiments were conducted some years ago and about 3,000 tons of standard peat fuel were manufactured and sold to householders in Ottawa and neighboring municipilities. The bog was then turned over to a private company for further development, but the company spent all of its money in getting ready to operate and had no capital left to carry on the enterprise; its plant was junked.

"The results of the manufacturing operations conducted at Alfred indicate that with strict business management, peat could be manufactured for $1.70 per ton in the field. This figure includes all charges such as interest on investment, amortization, etc.," writes B. F. Haanel, who is one of the four members of the Peat Committee of Canada.

Not more than 120 sun-drying days per annum can be depended upon in Ontario in the manufacture of peat, and as solar energy is the only known form of energy that is cheap enough to be economical in the manufacture of peat, therefore the material has to be laid out in the sun to dry after it has been excavated from the bog, and the minimum period under the most favorable drying conditions is about 30 days.

When the committee was appointed last spring, their first task was to design a modern machine. Mr. Ernest V. Moore of Montreal, was engaged as consulting engineer to design two plants, one of these will be similar to the one he already built at Alfred, but re-designed in the light of the experience obtained there. The other is an entirely new design, which if successful, will no doubt prove a distinct step forward in the manufacture of machine made fuel. It includes bucket excavators, a very efficient macerator, conveyors for laying the material in the field, spreaders, markers and mechanical harvesters. An industrial railroad system will gridiron the bog and little cars will carry the material to the railroad, and when, the peat is sufficiently dried, harvest it into a pile, and altogether it will be more simple and less costly per ton of output than any peat plant known.

After these plants were designed, manufacturing arrangements were made by the Committee. The factory of the William Hamilton Co., at Peterborough, Ont., is being largely devoted at present to the requirements of the Committee. The two plants will cost about $45,000, but neither of them is likely to be ready for extensive operation this year. It is expected that the two plants will produce a minimum of 20,000 tons next year, and the present program does not call for any additional plants to be put into operation.

As the fuel value of peat, compared with the average available anthracite, is as 1:1 8/10, 20,000 tons of peat will replace less than 12,000 tons of anthracite coal during the winter of 1919-20. The government's present idea is to see whether this 20,000 tons of peat, manufactured at Alfred under commercial conditions, can be sold through ordinary dealer channels, or by some other entirely commercial means, so as to compete satisfactorily with other fuels. If the new peat plant is demonstrated to be a commercial success (the government experts have no doubt about its success from a manufacturing standpoint), the governments do not intend to go into the peat business. They intend to leave it to private individuals who own peat bogs throughout Ontario, and who, aided by the official balance sheet in regard to those 20,000 experimental tons, may be able to secure capital to develop their bogs as private enterprises.

Assuming that the experimental sales made in the winter of 1919-20 are commercially successfully, it is quite doubtful whether private financial arrangements, and the manufacture of additional plants for private companies, can be carried out with sufficient rapidity to enable those private companies to make any considerable amount of peat fuel even for the winter of 1920-21.

Peat appears to be a most desirable fuel from every standpoint excepting its bulk, and with the present fuel scarcity, no one is likely to complain about that. Its calorific value is about 7,000 B.T.U.'s as compared with 12,500 for anthracite (or probably 10,000 for the average anthracite received in Canada last year). There is no clinker from peat, it ignites very readily, and its ash is very fine.

Excerpts from the Director General's Report.

In making his report to the President the Director General of Railroads calls attention to the fact of the increased efficiency through shortening of freight routes, heavier loading of cars, stimulating prompt removal of goods at terminals, standardizing designs for cars and locomotives and other operating reforms.

"Speaking generally, there is good ground for believing that substantial progress has been made in accelerating the movement of traffic, employing the available equipment more intensively and running trains more nearly on time.

"A daily increase in facility and efficiency is noticeable, and I am confident that the railroads will shortly be in condition to meet any demands that may be made on them if needed motive power, already ordered, can be secured and if the necesary skilled labor is not withdrawn from the railroads for military and other purposes.

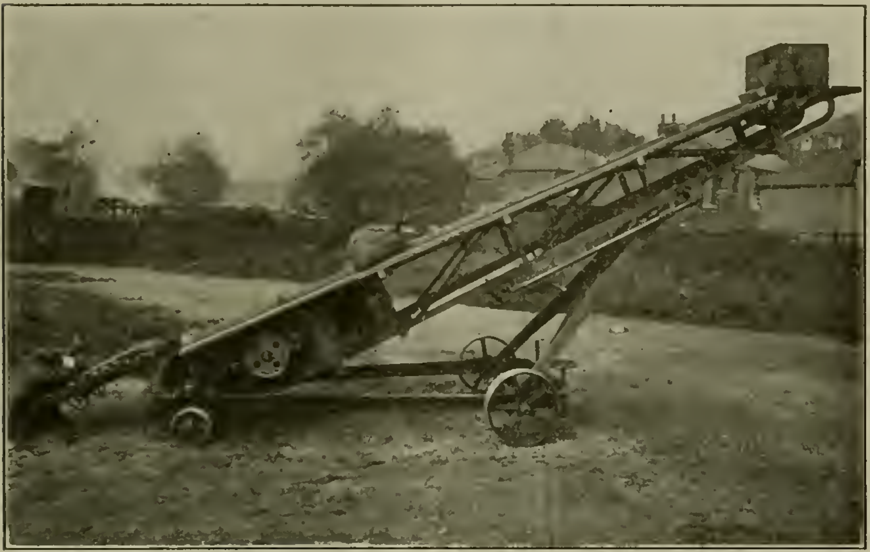
"Officials and employees have worked with such loyalty and zeal to accomplish what has already been done, that it is a genuine pleasure to make acknowledgment of their splendid work. It is a constant satisfaction to be associated with them."

Although no specific mention is made of the work of salvage, we may be sure the work is being effectively carried on. In this connection Mr. Otto H. Kahn, who has recently returned from a visit to Great Britain. France, Spain and the U. S. front, says, speaking of the work of salvage in Great Britain, that he went into the whole matter with Mr. Andrew Weir, Director General of Supplies and the army salvage system. In the space of three years there will have been saved to the nation through salvage, or, rather, in effect created for the nation, $500,000,000 out of things which formerly went into the scrap heap.

If we find ways of applying after the war, systematically in civil life, the lessons now being learned as to the use and value of materials heretofore considered waste, the possibility of the creation of wealth by that means in our country almost staggers the imagination. This idea of salvage of material by railways is one that opens up vast possibilities. It is only adapting to our needs the same principle which the British have made successful.

Gravity and Motor Conveyor on Freight Handling and Other Railroad Work

The handling of freight in car load lots is comparatively simple, because boxes, bales, sacks, cartons, etc., containing material sufficient to fully fill one car or more, are generally all of one size and weight, so that the amount for one car can be very fairly estimated, or if this is not done, one car properly loaded, gives practical data concerning all other similar cars. Therefore given an adequate method of handling freight, very little trouble will be experienced.



THE "BOOSTER," MOTOR USED WITH GRAVITY CONVEYORS.

GRAVITY CONVEYORS WITH LOOP.

This is not the case with L. C. L. freight (less than car load lots). No two boxes of this kind of lading are necessarily alike, either in size or weight and the destinations are various. The "Ardee" gravity conveyor is designed to handle car load lots and L. C. L. freight as well.

The apparatus consists of a series of rollers assembled in rigid steel frames of 8-foot lengths and of a variety of widths, which when placed so as to form a slight grade, will convey goods any distance, and the runway can be built in any direction. These frames are portable, they are easy to put up and easy to take down. The motion of the boxes is secured by the action of gravity. Two men can carry an 8-foot length, and at a pinch one man can do it. No skilled labor is required to fit up the conveyor or to take it apart. The frame is made of pressed steel and is trussed like a steel bridge between supports to insure rigidity, perfect alignment and free play for every conveyor roller. Each individual roller turns in case-hardened steel roller bearings which are housed in a manner that protects the bearings from grime and dust. The frames or units of the conveyor are joined together by a special interlocking coupler, fastened to the side frames. The hooks of one end of a unit interlock firmly and accurately with two flanged bolts on an adjoining unit, thus forming a strong, firm, connection, that can be made very quickly, or "unmade" with equal rapidity. The 8-foot sections can be added to, practically indefinitely until any required distance is covered. The coupling joints of the individual units insure instant connection when the conveyor is moved from one place to another. There is no bolting or screwing necessary, the sections hook together firmly, and automatically throw themselves into proper alignment. The runway is supported by very strong adjustable legs or supports. These can be altered to suit any pitch. Improvised supports found at hand can also be used. With the angle of these supports, the speed of the goods can be regulated. The sharper the pitch of the conveyor, the faster the material will travel. For conveying around corners or to clear columns in a shed, or other obstructions curved conveyor lengths are supplied, thus making the conveyor a system adaptable to all needs.

Ship loading conveyors are constructed on the principle of the endless chain. They load and unload continuously and therefore, more rapidly than the ordinary sling, which is necessarily empty a great portion of the time. But as Kipling says, "that is another story."

Rownson, Drew and Clydesdale are makers of this apparatus and the engineering principles, and the materials employed in the construction of the conveying system are based on many years of practical experience applied to general terminal work. It is not necessary to point out the endless variety of uses to which their gravity conveyors can be put in general railroad work. In the moving of material, especially in and around the larger divisional points, at foundries, in machine shops, and at store rooms and the handling of coal, the use of the portable conveyor and the elevator would effect great savings both in time and labor.

In connection with the great war in Europe it is said that the British used 200,000 men for a long time in France handling freight between the shipside at Calais, Havre and other ports and the various bases near the front. The railroads did not have adequate terminals, the piers and wharves did not have labor-saving devices and man-power had to be depended upon for nearly everything. The railroads were overtaxed and there were not enough auto-trucks for the flood of material that was constantly pouring in. Congestion was chronic. As a consequence the army suffered.

To get the immense number of boxed goods from ship to some point inland, the quartermaster's department was compelled to establish relays of men. One gang of thirty men would take boxes on their shoulders, carry them 300 ft., set them down and walk back to get another load without any delay.

Meantime another gang would pick up the boxes, carry them 300 ft., set them down and walk back. Then another gang would transport the stuff another 300 ft. and so on. The use of the "Ardee" conveyor, released 70 per cent of these men for fighting or other purposes, and the goods were moved with great saving of time. These are most desirable things in times of peace, and they are essential in times of war. Recently 40 miles of conveyors were sold to the U. S. and the Allies. They take shot and shell within speaking distance of the firing line.

To return to the question of freight handling, one of our illustrations shows a condition that may arise in peace or war. The idea is to keep the general level of the conveyor at about 4 ft. 6 ins., or 5 ft. above the ground. A height at which a box or other object can be reached by a man, anywhere along the route is thus secured, and the drop of the conveyor is about 5 ft. in 100 ft., or 1 in 20. The slope is approximately this, and the figure is approached as often as it can be. As a matter of fact, a conveyor line is greater (and especially on the field of war), generally much longer than 100 ft. At the point where the conveyor line reaches the ground, the high point of the next section begins, 5 ft. above the ground line. Here a gasoline engine or wherever electric power can be brought by wires, a motor is placed. The object of this insertion of power (gasoline or electric) is to raise the run down box, or other object, to the high point of the next section, so that it may continue its journey.

The 5 ft. hoist, by the gasoline or electric engine; which power is called a "Booster" is simply to raise the load from its run down position near the ground level, to the high point of the next 100 or 150 ft. The Booster does not operate the rollers of the conveyor system. The power to move resident in any box or case, is its own weight when placed on an inclined plane, formed of a series of smoothly running rollers. A long series of conveyor sections would roughly have the shape of an exceedingly flat saw-toothed roof on a factory, and the short, steep incline up which the Booster thrusts the load, simply gives a box or case the potential energy of position, when it reached the high point of any section, and this energy is turned into the kinetic form as the box rolls onward down the long, yielding slope of the conveyor, always at a height to which a man can reach in case any crowding or mishap occurred. The excellence of the whole system, however, renders such a contingency practically unknown.

Adverting again to L. C. L. freight, this matter is handled as shown in one of our illustrations. Such freight has no standard size of box, bag or case. Its destination is here and yonder, and its weight is far from uniform. The matter resolves itself largely into a question of sorting, and stowing. These things need judgment, but the conveyor is like an intelligent hod-carrier who brings stone, red bricks and white bricks to the mason, and at the same time takes the place of a man who sorts each kind into an appropriate pile. The conveyor does not sort goods, that must be done by a man, who is exempt from bodily labor. Once the sorting is done, the conveyor maintains the sorted group to destination. The conveyor may have short right-angle branches, with a man to divert each kind of freight, according to destination. He puts them on to appropriate short conveyor arms, or the whole system may be arranged as a broad conveyor from which at the unloading end, narrower conveyors are placed like the streams that flow through the Delta of a river. Another system makes boxes, bags, or cases take a designated side. An example of this in one illustration shows a conveyor stream branching, as if to avoid an obstacle and reuniting beyond it. It here forms a loop. A man at one end of the single stream may have freight for say New York and Boston, and suppose the shipment originates in a mingled, heterogeneous, mass at Pittsburgh. If he puts New York freight near the right side, it will go to the set of rollers nearest the pile of lumber seen in the picture. Boston freight if shoved to the left margin of the conveyor, will go to the left of the divided section. The man sorting the freight by putting New York to the right, and Boston to the left, has done his work, and the conveyor faithfully carries out or maintains his initial idea and action, even if he is beyond shouting distance from the men at the loop, whose duty it is to lift the boxes each for the city in whose interest he is temporarily working. The apparatus itself cannot think, nor use any judgment. The man does that.

CONVEYOR HANDLING COAL.


GRAVITY CONVEYOR ATTACHED TO BACK END OF WAGON.

A length of gravity conveyor can be attached to the end of a delivery wagon or truck and the man in charge, by the lessening of bodily labor, does more work and spends the bulk of his time in doing what is actually necessary, than he did before. He increases his capacity and does not play out, before quitting time. The object of bringing before mechanical department men, this efficient labor saving system, with all its attendent economies of man-power, time and money is because the system is applicable to the store house, and the large back shop, the coal handling plant, and the resting ground for repair shop material. It is itself a mechanical system, and at some points and sometimes it will require the knowledge, for maintenance, and repairs of men employed in the mechanical departments of our railway systems. When it comes to things more immediately connected with the mechanical department this system will be found adapted to the

needs that may arise in times of peace and in purely industrial work. Messrs. Rownson, Drew and Clydesdale have thus modernized many existing establishments.

The elevator system to which we have made brief reference, can be fitted with coal buckets and elevated to any height, or to the top of a permanent coal pocket. For store houses, folds of canvas may be provided for containing light, separate pieces, and is like the pocket in the front of a workman's overalls, which is used to carry light tools in. The "booster" by slight alteration, lends itself to the uses of a barrel hoist, and can be employed for handling fuel oil or lubricating oil, in a very expeditious way.

It also is apparent that the transportation and elevation of baggage can be done most quickly and with very little trouble by this system. The "faculty" which the machine seems to possess, of sorting goods, can be most facilitously applied to baggage movement at a busy terminal. The men using it as well as the men who will probably keep it in order, should known what the whole system is, all it will do, how it is made, and how it is operated.

Effect of Throttling Steam

Steam engineers have long been accustomed to believe that waste of heat results from throttling steam on its way to the steam chest, that it is hard for them to admit that there may be exceptions to the rule in favor of a full open throttle. We have recently read a paper prepared by Mr. Charles T. Porter, the celebrated mechanical engineer years ago, describing experiments he made to find out the exact effects of throttling steam. Mr. Porter appears to prove that under certain circumstances throttling saves steam. For a locomotive, the time when throttling would be beneficial would be when the engine was working so very light that the reverse lever might be kept in the center notch or very close to the center. Before Porter published the result of his investigations many locomotive engineers, the writer among them, claimed that they used less fuel at short cut-offs when steam was throttled.

Since Mr. Porter published the result of his investigation several of our friends have made tests and they unite in holding that a locomotive cannot be operated economically with a cut-off shorter than 25 per cent.

It is well known that locomotives and all other steam engines having cylinders exposed to the weather lose some portion of the steam by cylinder condensation. The range of temperatures of the cylinders is so great that the internal steam finds the cylinder acting as a condenser, since the metal has to be heated up from the temperature of the exhaust steam to that of the incoming steam.

The National Coiled Spring Journal Box

The Malleable iron journal box as perfected by the National Malleable Castings Company has largely superseded the ordinary cast iron box which was in general use when this company began the manufacture of Malleable iron journal boxes This type of journal box, is the result of many years of practical experience, and its outstanding or superior feature, apart from the excellence of the material is in the lid or cover which is so constructed that it remains absolutely dust proof, and also easy of operation.

The inevitable wear from the pedestals and equalizer bars, is also provided for by the use of hard steel inserts, cast into the pedestal guides and equalizer seats, These inserts give lasting wearing qualities.

Regarding the details of the lid, and its distinct features as varying from other designs of journal box lids, Fig. 1, shows the operating parts embracing the spring lever "C" pivoted to the inside face of the lid "B." The lever receives its thrust from a coiled spring "D" seated in a pocket in the lid, and transforms this pressure by full running against the hinge lug "E", into a powerful direct inward pull against the center of the lid at a right angle to it and the mouth of the box when the lid is closed, thereby maintaining a secure fit. It will be noted that the lid has a socket "G" which bears on a round trunnion "H" at either side of the hinge lug, and forms a bearing for the lid, so that the absence of the lid pin "E" in no way affects the security of the lid and operating parts.

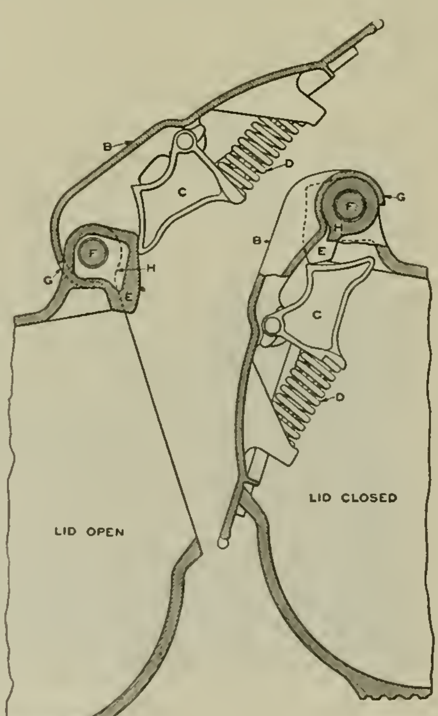


FIG. 1.

When the lid is closed the spring wedges the heel of the spring lever against the lower edge of the hinge lug, forcing the lid down tightly against the trunnions on the hinge lug, thereby preventing any wear of the parts through vibration of the truck while in motion. The working surface of the hinge lug, as well as all the operating parts, are in the inside, where they are kept lubricated by the oil in the box, insuring early operation and protection from rust. The device is equipped with a large and powerful coiled spring, which is very durable and positive in its action.

FIG. 2.

It may be added that the hinge lug is formed to permit the application and proper operation of the ordinary M. C. B. lid. The journal box conforms to all the essential M. C. B. standard dimensions, and can be furnished for both freight trucks now in general use either of the M. C. B., arch bar, pedestal or special types, and for all standard sizes of journals.

Fig. 2 shows a reproduction of a photograph of the coiled spring journal box with the lid in opened position.

New Coaling Plants.

The Pennsylvania has awarded a contract to the Roberts & Schaefer Company, Chicago, for the removal of the present elevating equipment at its coaling plant, at Conway, Pa., and the installation of its standard automatic-electric duplicate counter balanced elevating buckets, with R. & S. tram car distributing equipment on the existing bins. The Pennsylvania has also awarded two other contracts to the Roberts & Schaefer Company, one for a 1,000-ton reinforced concrete automatic-electric coaling plant at Columbus, Ohio.

Goggles More Than Protective

By WM. T. POWER, M.A., M.D., New York

Much thought has been given in recent years to the conditions of industrial employment. Public health officials and the medical profession generally have contributed their share by directing attention to the occupational diseases and to the unnecessarily great number of maiming, disfiguring and even fatal accidents. It has been shown that by careful attention to the details of environment, ventilation, illumination, hours of work and such conditions coupled with safeguards adapted to each industry, a surprising amount of occupational disease can be abolished and more than fifty per cent of the accidents formerly considered unavoidable, may be prevented.

It has been effectively demonstrated that these things pay. Not alone in the physical well-being of the worker, not alone in the mental satisfaction of the employer; but financially also. It pays in the increased productivity of the worker and in the obviating of legal expenses resulting from such injuries and diseases.

While appreciating in the highest degree the enormous benefits that have been derived from the well-nigh universal adoption of methods leading to the prevention of disease and injury, it is my present purpose to point out a field that has been so far all but totally neglected. I refer to the eyes of industrial workers. In making this statement, I recognize fully the fact that much has been done to improve lighting conditions and that devices have been adopted and rules promulgated to offset the danger to the eyes from flying missiles. I am not unmindful that carefully constructed goggles are in general use to protect the eyes of the wearer from injury by violence. I am also aware that colored glasses have been devised to safeguard the eyes from the baneful effects of the ultra-violet and other injurious rays and from the glare of incandescence and other menaces to the sight of the workers; but one phase of the subject has so far received scant attention and that is the presence of refractive errors in the eyes of the worker. A refractive error is any defect in the mechanism of the eye interfering with the accurate focussing of images upon the retina. This defect may cause defective vision or it may be overcome and accurate vision attained by a faculty of the eye known as accommodation. In either case it causes eyestrain. Eyestrain may manifest itself in numerous ways such as simple inflammation of the eyelids, headache, fatigue, drowsiness, vertigo, so-called "bilious attack" or even severe mental disturbance.

The great benefits derived from the examination of the eyes of school children and the correction of their refractive errors are familiar to all. The improvement in vision, the abating of nerve irritation by the relief of eyestrain and the resultant sense of general well-being bring about a greater capacity for work. It is but logical to assume that if an exhaustive campaign were made to discover and correct the refractive errors of industrial workers it would be productive of results no less strikingly beneficial than those obtained among school children, in fact it would seem that such a campaign would accomplish much greater and more far-reaching results.

As the great mass of workers is recruited from the ranks of foreign and native born individuals whose educational opportunities have not been great they may be said to be in practically total ignorance of the handicap imposed by refractive errors. The average manual laborer is of the opinion that glasses are quite proper for the office man and the man of education and refinement, but for him to wear them would be a confession of weakness or affectation as he imagines that they do not belong to his sphere of existence.

All unknown to the individuals themselves errors of refraction are of very frequent occurrence among industrial workers. The consequence of this is not alone inaccuracy of vision but all the concomitant, distressful symptoms of eyestrain. This is a serious handicap to the comfort and physical well-being of the victims as well as a bar to their efficiency and advancement.

The first step in this direction must be to educate both the employers and the workers up to a receptive condition of mind. The employer must be taught to recognize the fact that his workman is no more unfitted for his exacting fine work by the correction of his refractive errors than is he himself unfitted for conducting the business of his office because he must wear glasses to read his letters. And the workman must learn that his employer has come to think that way. The way has been prepared by the widespread use of protective goggles—which fortunately can be ground to prescription.

If we are going to put goggles on the workingman, let us see that these goggles not alone do him no injury but that in them he receives all the benefits that our skill can devise.

In the past there were three main reasons why the workingman did not wear glasses:

First.—A lingering prejudice founded in a belief that the wearing of glasses was an affectation of elegance or style that did not belong to his walk of life.

Second.—Ignorance of what constitutes eye strain and the benefits to be derived from properly fitted glasses.

Third.—Fear of injury to his eyes from the breaking of lenses. This fear shared in by his employer who preferred men who did not wear glasses.

The last was probably the most potent reason of all.

The protecting goggle has done away with all of these barriers. Now that these goggles have so demonstrated their efficiency that they are a feature of industrial equipment; now while they are comparatively new and while their use is spreading so that the time is not far distant when every man whose eyes are even remotely endangered by his employment, will be required to wear them; now is the time to advocate that when goggles are being fitted that the vision should be tested and the goggles utilized to correct all errors of refraction.

When we consider the thousands or perhaps hundreds of thousands of workmen now equipped with protective goggles, the thought arises that peering through these lenses, there must be an infinite variety of eyes. There are undoubtedly among them numerous examples of every abnormal or anomalous condition to which human eyes are subject. There are, of course, many normal eyes, but there must be also among them eyes afflicted with diseases of every description, every variety of corneal and lid affection and muscle trouble.

It is patent then that a goggle to be readily adaptable to any and all of these types of eyes amid all the variable conditions under which industrial workers are placed, to be at all times and in all circumstances useful and beneficial must of necessity be the product of the highest type of the optical art.

It would seem but the part of wisdom to examine the goggles critically and determine whether or not they may contain any subtle or hidden influence for harm.

It goes without saying that the lenses must be made of tough glass capable of resisting great violence, but if the impact be great enough to cause the lens to break that the fragments will not enter the eyes of the wearer. That the lens must be clear, transparent and of such size, shape and so positioned as to give a wide unobstructed field of vision. That it must not distort, magnify nor minimize the objects looked at.

These requirements are obvious and are of course essential to the success of any

goggle on the market. But there is a defect which may be present in lenses which will fulfill all the requirements so far enumerated, a defect not apparent to the wearer and not readily detected except by most accurate and expert examination and that is the presence in the lens of a prism of low degree. The lens may have a smooth surface and appear quite perfect but if one segment of the circumference is ever so slightly thicker than the rest of the circumference, then that lens is a prism.

The unintentional presence of such a prism is capable of working great harm to the wearer.

Just as therapeutically a prism may be utilized to restore the muscular balance in an eye afflicted with muscular imbalance, so a prism placed before the eye in which the muscular balance is normal will throw out of balance the muscle over which its influence is exerted. If the wearer had already a latent muscular imbalance, the prism would tend to aggravate this condition, unless by sheer good luck the base of the prism should chance to fall into a position favorable to the weak muscle.

The importance of this lies in the fact that the injurious effect would be insidious and slow in development and the cause not readily detected. The symptoms would probably be ascribed to eyestrain, and careful and skillful examination of the eyes themselves would not disclose the cause of the difficulty.

There is no disputing the fact that the constant wearing over an extended period of a prism not therapeutically adapted to the eye, is harmful. The harmfulness will vary with the strength of the prism and the nature of the work demanded of the eye, as well as the condition of the eye itself at the start.

These protective goggles have accomplished so much in the saving of human eyes that it is well to make them more perfect and to eliminate any possibility of harmful effects from their use. This can be done by rigid examination of every lens by a delicately adjusted instrument capable of detecting the slightest variation in the thickness of the glass.

I have dwelt at some length on this particular subject because it is the one of most frequent occurence in the goggles now on the market.

If we could bring about conditions whereby every individual who is required to wear protective goggles would have his vision tested and corrected by the goggles, the benefits derived would be such an object lesson to employer and employees, that it would lead in the near future to the correction of refractive errors of all workers whether their eyes were exposed to injury by violence or not. This is an ideal well worthy of the medical profession.

Steam Gauge Glasses

A good steam gauge-glass is a safety appliance of the highest value. True, there are on a locomotive three try-cocks, and a careful man can get along very well with them, but all men are not particularly careful, so that a safety appliance has to be made so as to save the careless man. The opening of a try-cock requires remembrance, and that is a mental act. It requires manipulation, and that is a bodily act, and another mental act follows, that of appreciating what the try-cock reveals. The gauge-glass, however, is always before an engineman, and a glance tells the tale. Muscular exertion is eliminated, and the mental process of remembering to test the height of the water is absent. The gauge-glass is economical, as it only requires one thought instead of two and no manual act.

This all being true, the natural idea is to get the best glass for service conditions. The Moncrieff glass appears to be the best made abroad, and the Libbey glass in this country. The requirements for a good glass are more than a hasty thinker would imagine. The glass must be clear, strong, non-corrosive in alkaline waters, and above all it must be able to stand wide or violent fluctuations of temperature. Clear and strong glass does not entail a difficult or secret process in its manufacture. The non-corrosive element is the result of methods which the makers keep to themselves, and the ability to withstand heat and cold is the result of the "make up" or the constituents of the glass, and the way it is worked in the process of manufacture. We usually regard glass as a close-grained, dense, hard, solid substance, but in reality as a gauge-glass it has some of these qualities, only, but not all. Hard, bright, flint glass called "paste," is used to imitate the diamond, and its brilliant sparkle, and its ability to be cut with small facets, and to take a high polish, make it a good imitation of Nature's gem. This glass, however, lacks one essential characteristic for high-pressure steam and water glasses, and it would be unserviceable for our purpose if drawn into the form of a tube. The quality that flint glass lacks, and which resists heat and cold is present in the "Unific" glass for high pressures. It and the "Perth" glass for low pressure are made in Scotland.

There is a quality which makes a gauge glass, good, and this quality, for want of a better name, is "porosity." Here however the word "porosity" is inaccurate, because we usually associate it with cavities like those found in a sponge. In the Libbey make the glass "pores" are far less than these, and would probably defy a powerful microscope. Yet the pores exist, filled with what, we know not. It may be air or gas from the fused glass constituents, or it may be ether. The pores are there, and the spaces that these exceedingly small globules occupy are separated by distances so short that the very word "distance" loses its meaning when describing a thing so minute and this thought of distance is thus brought to the very verge, of rational conception. Yet these tiny spaces, which are almost the vanishing point of small compass, have place, and probably form the slipping locations for the molecules of the glass, and so allow a cold exterior to co-exist with a hot interior, and such infinitesimal "porosity," takes up the expansion or contraction due to the sudden cooling or heating, which may come from without; and they thus avert a crack or break in the clear glass tube.

Little things, go into the "make-up" of a good glass, capable of standing internal stress and of resisting strain due to knocks, jars and the constant vibration of a locomotive in motion. The longer the life of a gauge glass, the more economical it is to buy; and we know that the easier it is to put in place, the better it is from a mechanical or operating man's standpoint. The Libbey glass has these characteristics, for this firm is not a novice in glass making. The ends of the glass tubes, after having been made, are fused, so as to seal up the minute "pores," of which we have been speaking. The sealing up process is proof of the existence of these exceedingly small spaces, because when sealed, they resist the concentrated corrosive action of alkaline or other impure water, and prevent the ends from being eaten away and so cut off, before the glass would otherwise be considered as out of service. The sole agency for the Libbey glass has been taken by the H. A. Rogers Company of 87 Walker Street, New York, N. Y., and the glasses are most emphatically the best "Made in America" glass.

The French government has finally decided to introduce a bill providing for the taking over of the railways during the war and one year afterward. The measure is expected to pass without opposition.

Marc Séguin and His Work—The First Tubular Locomotive Boiler

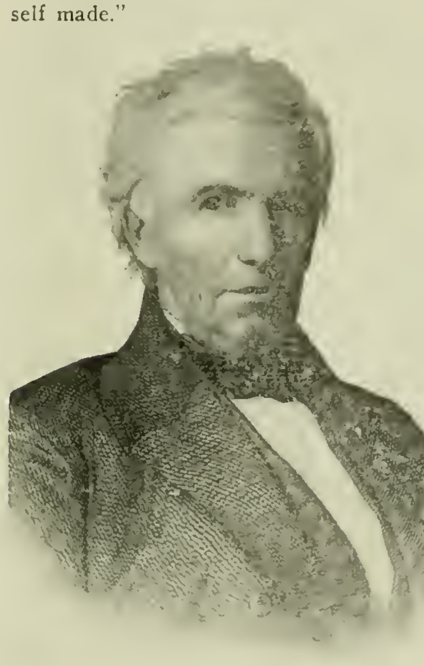
By J. SNOWDEN BELL

The literature of the locomotive engine may probably be properly considered as commencing with Nicholas Wood's well known *"Practical Treatise on Railroads,"* London, 1825, and the statements of that author, as to the origin and early development of the locomotive, have been accepted, and adopted without substantial variation, in the numerous treatises on this subject matter, that have succeeded his book, in Great Britain and the United States, as correctly indicating all the various steps of improvement which were sufficiently novel and characteristic to be worthy of historical record.

The history, as stated in these later publications, is, however, so far as it has been studied by the writer, materially incomplete, in failing to develop the origination and first application, by Marc Séguin, of the tubular boiler, which was undeniably the essential and most important feature of the practical success of the locomotive. It is true that Séguin's work is mentioned in Colburn's *"Locomotive Engineering,"* London, 1871, pp. 22, 23, but credit is not given to him as an originator, and, on the other hand, an attempt is made, by an excerpt from the Neville British Patent No. 5344 of 1826, for a vertical boiler for stationary purposes, to deny the originality of Séguin and his right to be credited with this important improvement. As a reply to this denial, it is hoped that the following statements of Séguin's character and work, and illustrations of his original application of the tubular locomotive boiler in practical railroad service, may be found to be a measure of justice and a proper contribution to the historical record.

In the review of the early history of locomotives, appearing in the Introduction to *"Guide du Mecanicien Constructeur et Conducteur de Machines Locomotives,"* by Le Chatelier, Flachat, Petiet and Polonceau, Paris, 1859, Séguin's tubular boiler is referred to as follows (pp. 10, 11):

"A French engineer, M. Séguin ainé, director of the Lyons and Saint Etienne railroad, had brought at that epoch [1825] from the shops of Stephenson, two locomotives conforming with the preceding ones; after numerous observations and well followed experiments on suitable means for increasing the steam generating power of these engines, and consequently their speed, he invented the replacement of the interior flue by a large number of tubes of small diameter and slight thickness; he thus increased, in considerable proportion, the surface of contact of the hot gases produced by combustion, with the water which was to be converted into steam. It was not sufficient to increase the heating surface, and it was necessary to also increase the activity of combustion, for which natural draft, in a chimney of restricted dimensions, was insufficient. M. Séguin used a fan blower, operated by the movement of the engine, which he first worked under the firebox and then in the chimney; he took out a French Patent, December 20, 1827, for the realization of these two ideas, the application of which he himself made."



SÉGUIN.

The accompanying portrait of Marc Séguin is reproduced from the frontispiece to Vol. 2 of Aug. Perdonnet's treatise, *"Traite Elementaire des Chemlus de Fer,"* Paris, 1860, from which (pp. 359-362) the following notice of his career is extracted.

"Séguin l'ainé. Séguin the elder whose portrait we have placed at the front of the second volume, was the nephew of Montgolfier. The inventor of the high-speed locomotive is the nephew of the inventor of balloons. The invention of balloons has been received with immense enthusiasm; that of the steam locomotive produced at first but a weak impression. What far realizing difference there is in the results of these two discoveries.

Marc Séguin was born at Annonay, April 20, 1786. His first education was neglected, and perhaps his brilliant qualities would not have been developed, if he had not had the good fortune to meet the best and most devoted of instructors in his uncle, Montgolfier, who had recognized his good disposition for study.

"In 1820, he entered the career of civil construction by a master stroke. New roads were being constructed, and those already constructed were being improved. It was necessary for the best results to find a means of crossing rivers at slight cost. Séguin discovered it. After having made numerous and important experiments, on the resistance of iron, used under different forms, he constructed, basing it on these experiments, the wire suspension bridge of Tournon. This bridge cost only 200,000 francs. A stone bridge would have cost three times as much. Notwithstanding the strong opposition that the construction of wire suspension bridges encountered, on the part of the State engineers in France, more than four hundred bridges of this kind have since been built at different points, all upon analogous plans, and the Americans have recently constructed a bridge of this type for the passage of a railroad across Niagara.

"In 1825 and 1826, Marc Séguin, associated with the sons of the illustrious Montgolfier, and with his brothers, made the first attempts at steam navigation on the Rhone. It was then that, for the first time, he used a tubular boiler; but another occasion soon presented itself for employing that boiler with much greater advantage."

"Messrs. Séguin brothers had obtained in 1825, the concession of the railroad from Saint Etienne to Lyons. Marc Séguin from 1827, there used the tubular locomotive boiler. In February, 1828, he took out a Patent for that boiler, and it was no more than a year and a half thereafter (October, 1829) that analogous ones were seen at the locomotive trials on the Liverpool and Manchester railway."

"Did Mr. Booth, secretary of that railroad company, to whom there has sometimes been attributed the merit of the invention of the tubular boiler, or Mr. Stephenson, the constructor, have knowledge of the Séguin boiler when they laid out their plan, or did they have the same thought at the same time, or near it. This is a question that we will not pass upon. It is entirely possible that two men of genius may have had the same thought at the same hour."

"We have seen the working of the first Séguin tubular boiler locomotives. They

made much more steam than the older ones; but the draft effected by the air projected from the blades of wheels did not make the best conditions. The steam jet was substituted for these wheels. It was a new progress."

"The construction of the railroad from Saint-Etienne to Lyons presented great difficulties. The most of the engineers of that time, proposed to overcome them by means of inclined planes, as was then done on a large number of roads in the environs of Newcastle. Séguin did not recoil before these considerable works which necessitated a grade and curves of a radius of 500 metres. He had divined the future. It is a characteristic of men of genius to advance their epoch. We have heard Stephenson himself express his admiration for this laying out of the road which so many others then considered as defective."

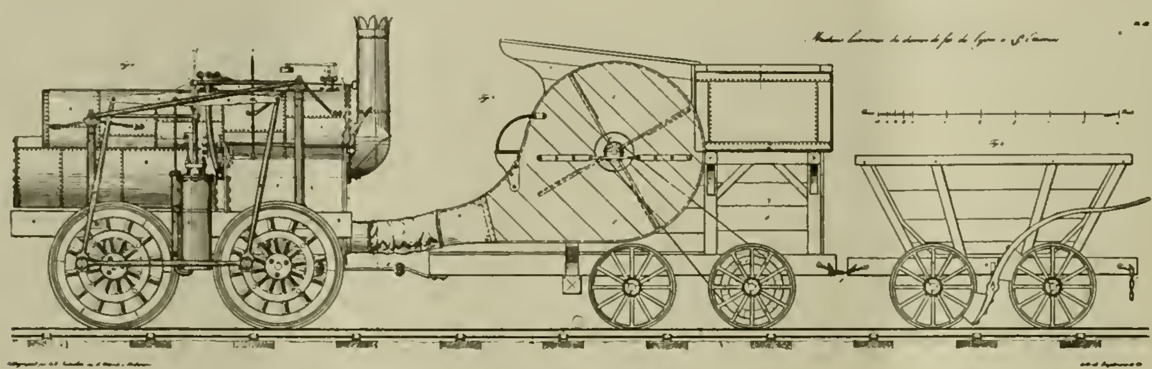
"Séguin the elder, it is proper to say, was ably seconded in his works by his brothers, Camille, Paul and Charles, who were happy in execution and happy in administration."

"In 1857, we find Séguin occupying himself anew in steam navigation on the Rhine. In 1839, when there was hesitation as to the part to be taken in the construction of the French system, he published a work which made a great sensation; this work was entitled: *'On the influence of railroads and the art of laying out and constructing them.'*

"Patron of all our glories, Arago had appreciated the services rendered by Séguin to science and industry; he was, in 1842, named, on his presentation, corresponding member of the Academy of Sciences."

"Indefatigable worker, Séguin the elder, already loaded with years, still studies a new engine, always working with the same steam, to which there is restored, at each stroke of the piston, the heat that it has lost in producing the mechanical effect, and he devotes himself to scientific researches on cohesion, researches on which we do not venture to give an opinion, but which, perhaps, are of wide scope."

"Who would not believe that the inventor of the locomotive has been loaded with the favors of sovereigns whose States have seen their prosperity increase so rapidly by the establishment of railroads? Nevertheless, this is not so. Séguin the elder, simple chevalier of the Legion or Honor, lives in modest retreat, nearly ignored, but the figure is noble of that patriarch of industry, surrounded by a beautiful and numerous family, ceaselessly occupying himself in perfecting his work."

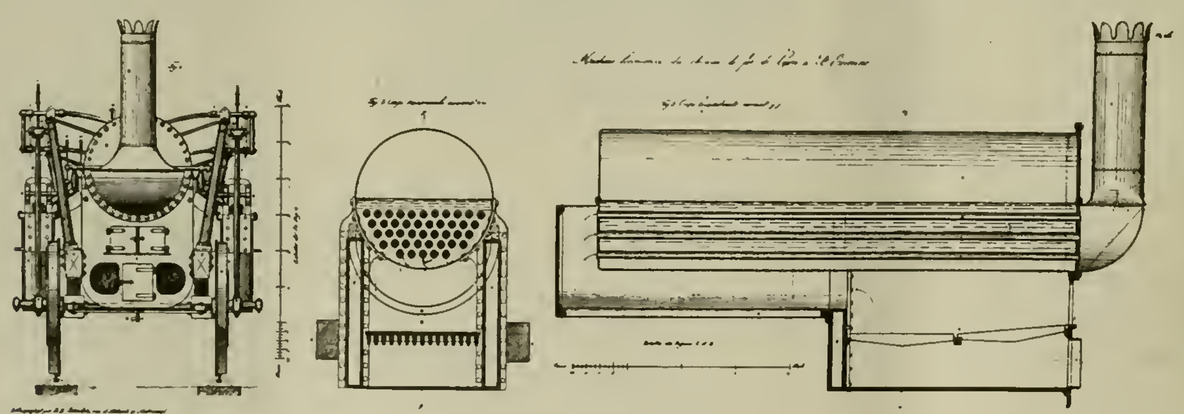


THE SÉGUIN LOCOMOTIVE.

THE SÉGUIN TUBULAR BOILER LOCOMOTIVES.

The "Bulletin de la Societe Industriel'e de Mulhausen," Tome Cinquienne, contains a very full and interesting report, by Messrs. Albert Schlumberger and Emile Koechlin, read at the session of October 26, 1831, upon a trip taken in the name of the Society, to examine the new system of steam boiler of "Messrs. Séguin & Co., at Saint Etienne." (pp. 169-187, Pl. 63, 64). The construction of the boiler and the performance of the locomotives on the Saint Etienne and Lyons railroad are clearly shown and described in the accompanying illustration, which is a reduced reproduction of Plates 63 and 64, Tome Cinquienne, of the Bulletin, and in the following notes, which are abstracts from the text of the report.

As shown in the side elevations, it will be seen that the locomotive is of the early British type, having four coupled driving wheels and vertical cylinders, with long cross-heads, the ends of which are coupled to the driving wheels by main rods. The tender carries two fan blowers, which are driven by a belt from one of the tender axles, when running, or rotated by hand when draft is required while standing, the air blast from the fans being delivered below the grate. A small four-wheeled coal car or "chariot" is shown coupled to the tender.

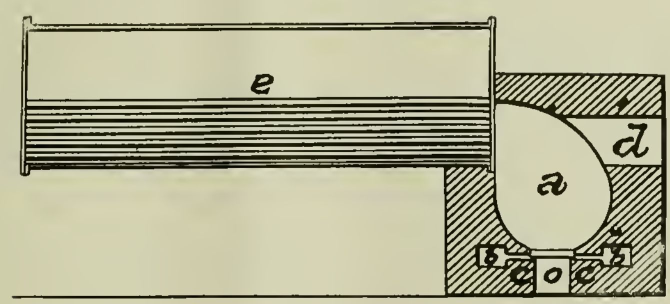


THE SÉGUIN LOCOMOTIVE.

The following are the particulars of the boiler as given in the Bulletin:

The firebox is 4 feet (1 mt. 30) long, 2 feet 4 inches (0 mt. 75) wide, and is placed between two double "fonds" of cast iron, filled with water and communicating with the interior of the boiler. In the bottom of the firebox there is another cast iron piece, also full of

water, which communicates with the boiler, which is fixed on it. The grate is composed of two rows of 17 bars, and there are 43 small fire tubes. The whole, with water, weighs 3000 kilos (6613.8 pounds). The tension of the steam is three atmospheres above that of ordinary pressure.



THE SÉGUIN BOILER.

Weight of engine and tender 6,000 kos. (13227.6 pounds), price 10,000 francs.

Heating Surface.	Square metres.
Cylindrical part	2.56
2 demi bases or flat part	0.55
43 tubes in the boiler	15.78
2 double bottoms on the 2 sides of the firebox	0.35
Reservoir of water under the boiler to supply the feed pump	1.95
Total	23.47

Say 23½ square metres=252.9 sq. ft.

Particulars of Engine.

Diameter of pistons	0.23 mt
Stroke of pistons	0.60 "
Density of steam in atmospheres	4.00 "
Each cylinder filled twice for one turn of crank or one cylinder four times	4.00
Number of turns of crank per hour	3600
Volume of 1 Kilo. of Steam at 135 degrees or 3 atmospheres	1922

Experiment.

The engine taking up empty chariots and the two blowers working, 100 kilos of coal were burned in one hour, and 785 kilos of water were taken from the reservoir. One square metre of heating surface evaporated in one hour 785/23.5=33 kilo. 4. One kilo of coal=7 kilo. 8.

The chariots weigh 1000 to 1100 Kilos, and can carry 2000 Kilos of coal.

The engines haul 20,000 Kilos (25 to 30 empty chariots) at a speed of 2 metres per second, say 4.4 miles per hour.

The inclination of the rails, from Rive de Gier to Givors, is 0 mt.00569 per metre, and is sufficient to allow the loaded chariots to descend by their own weight.

The grade from Lyons to Givors, a length of 21,150 metres, can be considered as null; from Rive de Giers to Givors, a length of 16,300 metres, it is nearly 6 m/mt per metre (0.00569) which is near the limit after which it becomes impossible to mount by the simple friction of the wheels of the locomotive on the rails. From Saint Etienne to Rive de Giers it is 13m/mt per metre (0.0134) over a length of 18,600 metres.

The date of Séguin's Patent is incorrectly given in the *"Guide du Mecanicien,"* his French Patent, for the invention of the tubular boiler, being dated February 22, 1828, No. 3744. As shown in the single Figure of the Patent, which is reproduced above, the setting of the furnace is of brick, and the furnace is stated to be supplied with air by a blower or otherwise. The invention is broadly defined as consisting in "a greater or less number of tubes which are traversed by the heat, and these tubes, surrounded by water, form a very large heating surface."

There is no evidence that the tubular locomotive boiler was designed, proposed, or put in service by any one, prior to Marc Séguin, and the great credit which is due him as its originator should not, in the view of the writer, be in anywise impaired by the mere *suggestion*, in the Neville British Patent No. 3544 of 1826, that the tubes of the vertical boiler therein shown, may, "In some cases," be placed in "an horizontal or oblique position, particularly where altitude of such apparatus should be found inconvenient."

Measuring Steam by Meter

Considerable economy in fuel may be obtained by supplying steam from a plant which is working under economical conditions to steam-using apparatus.

In a certain works there was a plant consisting of four water-tube boilers of 240 to 350 sq. m. heating surface and a working pressure of 180 lbs. per sq. in. A new steam main about 328 ft. long and 2½ inches diameter was installed to connect the two works, and a reducing valve fixed at the end. A mercury differential pressure gauge was fixed at the entrance to the works and also a steam meter. It was agreed that the charge to the consumer should be the actual cost of fuel which he would have had to use to generate the steam.

Automatic Stops in Canada.

The Board of Railway Commissioners in Canada have recently issued a circular, dealing with automatic stops on railways. In dealing with this specific subject, a kindred object invariably comes up, and that is the matter of train control, which has for its object not only the saving of life, but by its action is said to increase the track capacity of the road. The circular issued is as follows:

"In view of the frequency of accidents, as shown by reports made to the board from time to time, indicating that some grave consideration should now be given by Canadian railways to the question of the advisability of adopting an effective automatic train stop device, the board, in full realization of the necessities of the situation brought to its attention, desires an expression of the views of each railway company under its jurisdiction upon the subject after full consideration and investigation has been given by the railways. It is suggested that the Canadian Pacific, Grand Trunk, Michigan Central, Canadian Northern, St. Lawrence & Adirondack, Grand Trunk Pacific, and Toronto, Hamilton & Buffalo railways should appoint a special committee to consider the matter, and report.

Safety First.

"In its 'Safety First' Work the Safety Section of the Division of Transportation, United States Railroad Administration, intends to utilize to the fullest extent the safety organizations now in operation on such railroads as have working organizations, and to assist those railroads not having a safety organization to perfect such an organization as will keep constantly before the minds of all officials and employes the necessity of care and caution so as to insure greater safety in railway work that may be brought about in every possible way.

"This is a great humanitarian and philanthropic work in which science, labor, business enterprises, and the government must all unite. In science the appeal is especially made to the mechanical engineering profession and it is asked to furnish the safest equipment; to statistics and economics to furnish facts and to supply methods of investigation and of prevention; but the greatest need of all is the help of labor, which has the greatest immediate interest in the matter. It is too often handicapped by the lack of scientific knowledge, or by a lack of means of making itself heard. All organizations and all societies can be of material benefit and of great service in pointing out fields of investigation, so that unsafe conditions may be corrected, but better still they can assist in instilling into the mind of every employe, the fundamental rule, that no chances of any kind should ever be taken.

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The Greater Mechanical Department.

The mechanical department of olden days was a wide-reaching department. Its scope included the repair of all manner of things, not only engines and cars, for the rehabilitation of which it was originally organized, but for the repair of anything a railway uses. Office chairs, desks, typewriters, cases, letter presses, book shelves, etc., etc., came to it for overhauling. In fact at first the mechanical department was a huge manufactory, which made locomotive tires, car wheels, sheet steel, and a variety of articles which are now bought in open market.

The change from this wide-reaching plan came about gradually. Specialists in the world outside the domain of the iron horse, devoted their energies to the making of one thing and doing it supremely well. Railway supply houses proved to be able to turn out articles cheaper and better than could be made by the consumer and in time much of what was formerly made by railways, was turned over to manufacturers and their agents.

This seems to imply that the railroad mechanical department shrunk in size and power, and though this is to a certain extent true, it did not turn out to be the absolute state of affairs. It has today two effects upon those who work directly and indirectly for railways. In the first place it never took away from actual railway workers, what we may call the emergency call. Much of the material bought by the railway in the first place, was liable to failure at any time and often at undesirable places.

This does not say that failure was the rule, far from it, and for the very reason that the goods are made by specialists in their own line. These men had focused their attention on particular aspects of the case, and they had carefully noted defects of workmanship, of design and of material. Where it was possible they had applied a remedy, and excellent results became the rule rather than the exception. Yet failure was and is always a possibility, and it behooves the railroad man, even if he is not a specialist, at least to have acquired such knowledge of a special appliance as to be a proficient workman so that he may relieve a blockage on the road or permit an engine or car to be quickly moved to a divisional point and so got out of the way, until reached by the necessary force of men with tools and appliances.

One of the ways for acquiring such knowledge is through the literature of the supply houses and through the pages of the periodic technical press. Much of these forms of literature are intended to instruct those who have to deal at close range with accessories. It is a form of "first aid," that is often quite indispensable. This form of reading is not necessarily intended to only catch the eye of the president or other high official. The whole subject of locomotive operation and car design and maintenance, is too important and too complicated to be left to a workman who is confronted with it, for the first time, in a break-down or a failure. "Forwarned is forearmed" is a motto as applicable to the mechanical department of a railway today, as it was in the days of general warfare or single combat.

The mechanical department of a railway is manned by skilful men, who can be relied upon; but the railway system of our continent is supplimented by the efforts of what we may, with all good will, speak of as the ununiformed force. These men are the particularists and the specialists of the mechanical profession. They build and equip locomotives and cars, and though they do not operate them, these men are conversant with all the details, and with the stresses and strains of operation. These men have time to devote to theoretical questions of design, as well as to the more onerous duties of operation. A system of "service," if it may be so called, is carried on by these men, and failures are investigated as well for the benefit of the railways, as for the information and guidance of this "plain clothes" force, every ready to look for the cause of failure and to assist those who operate the machines.

These "plain clothes" men of the rail have detailed a corps of men to equip, or supervise the equipment of their goods on railways. They are prepared to "stand by" and to give instructions and explanations, until successful performance is established. So it comes about that efficient and scientific performance results from "service." At the present time a phonograph in the President's car may not be considered as a legitimate field for operation or repairs for the mechanical department, as it might have been in early days, had it been in existence. The vital economies in railway operation; originated by specialists, and often supervised by them, until knowledge and ability to "go it alone," is possessed by the rank and file of the mechanical department; are more efficiently attended to than ever before. The old proverb, of two heads being better than one loses nothing of its essential truth, while finding a wider application in making the uniformed force and the plain clothes man of the railway one large, comprehensive organization serving different leaders, but striving for the same goal, and for safety, economy, and successful operation, all along the line. Thus with those in actual railway service and those interested, who serve outside, is the greater mechanical department brought into being.

Recent Collisions and Their Lesson.

The findings of the Federal Commission on two unusually serious railway accidents, a condensed report of which occurs elsewhere in our columns, brings forcibly into notice the need of further improvements in automatic stop appliances. Inventions that aim at preventing an engineer from running past a danger signal are of service only in so far as they are obeyed. An engineer frankly admitting that he was asleep as his train rushed in to the destruction of scores of human lives, is not in a condition to be impressed by signals intended for the eye alone. The evidence in the disasters referred to show that a strongly built steel car will not be telescoped by any kind of collision with which we are familiar, but there is no doubt that the shock of a collision which is not taken up by some one or more of the vehicles in the train would probably result in the severe injury of the passengers.

We had recently a visit from an inventor who claimed that he had a device that would stop a train running at 40 miles an hour within a few feet. In such a case the passengers would all have the velocity of 40 miles an hour, and to suddenly stop this would be almost equivalent to a personal collision of each passenger with parts of the car; in fact, the partitions and seats and car end would appear to

rush at them with a velocity only slightly less than 40 miles per hour, as they were hurled from one end to the other.

In one of the accidents we have a vision of the chancetaker, that anarchist of the road. Good discipline on American railroads is improving, but the stricter enforcement of discipline will, as we have repeatedly stated, never meet the exigencies of railroad service, as long as it depends entirely on the human element. The use of improved automatic stop signals, if they could be made suitable for all conditions of weather and become as reliable as those used on the New York subway would meet the situation. All that is wanted, is the universal application of a stop signal that is simple, workable in winter as well as in summer, and that it shall effectively apply the air brake automatically in case of emergency.

Soot and Scale and Tired Arms.

Coal must not only be burned fully and properly, but it must be handled quickly and carefully, if we are to make up the quantity for 1919 which ought to be saved over that used this year. The careful handling of coal means the innumerable instances where odd lumps and small quantities dropped here and there, must be eliminated. This is just one of the ways that coal conservation can be aided.

Next comes the consideration of the importance of burning the volatile gases that arise from the coal bed. These gases must be delayed in their rush to the smoke stack in order that they may be thoroughly mixed with the oxygen of the air. The brick arch and the combustion chamber are very potent aids in this matter. If the volatile gases are not properly burned, a loss of heat ensues. Soot or smoke is the evidence of incomplete combustion. Soot is formed at the surface of the fuel bed by the absence of oxygen.

If sufficient air is supplied, there will be (theoretically) no smoke. Soot is the enemy of heat transferrence. It not only means a loss of heat in its very formation but it interposes a very troublesome barrier to the heat as it tries to pass through the firebox sheets and tubes to the water. It practically insulates the steel sheets of the firebox, and the tubes, and so keeps out part of the heat that is formed from reaching the water. The remedy is to prevent the formation of soot as far as possible, and also to see that the tubes are clean. Any fireman on an engine filled with soot has to work harder than he would work, if the tubes were clean.

The fireman lifts shovelful after shovelful on the trip. He raises weight, and this is a "back-breaking" process if persisted in for any length of time. It means that some of the coal so lifted fails of the object the fireman has in view, that of generating heat and he has to lift more shovelfuls to make up the deficit. Suppose a hard working fireman had an ill-natured child on the seat beside where he stands, and for the sake of malicious fun, the child kicked part of the coal off the scoop, every time the fireman raised it. It is not hard to see that the child would increase the work of the fireman, and yet the result, as far as the engine is concerned, would be no better with soot forming than if the child was off the engine. The extra work might amuse the ill-natured child, but no more steam would be shown on the gauge, and coal would have been wasted and the fireman needlessly fatigued. Soot is the ill-natured child on the engine, in fact soot is worse, because it needs extra work at the terminal, and some one must remove it.

The formation of scale is somewhat analogous to the bad influence of the soot. In fact scale is a still more ill-natured child on the engine, but he is not sitting on the seat where he can be got at and put off (the non-formation of soot). Scale is the demon inside the boiler, and if left to itself, will put a coat of insulating material on the water side of firebox and tubes. The fireman will have to work harder than ever and do no more good, if he keeps the steam pressure up to normal. A crust of scale 1/32 of an inch thick, results in a loss of 11 per cent in fuel. If the scale is let accumulate until it is ½-in. thick, the loss will be 60 per cent. Water-softening is one of the principal and very effective methods of preventing the formation of scale. Frequent boiler washing is also a good preventive measure.

The water softening plant must be put in by the railway, but that does not prevent a fireman from using his influence to get it, or the brick arch considered. The combined influence and voice of a number of men who have to "go up against" the conditions which we have here outlined cannot fail to be productive of beneficial results. The saving of coal just now is good business; it is in a sense, a war measure; it gives a chance to display patriotism, and help to win the war. A serious feeling engendered among the rank and file of railroad men, cannot pass unnoticed by officials, now-a-days, especially when the men are not alone thinking of their needlessly tired arms, but are advocating a real, necessary service to the country.

Coal.

A plant using a carload of coal a day that is working at 60 per cent efficiency would waste more fuel than is consumed by all the great electric display signs in New York City. The conservation of coal, to be effective, becomes the problem of the individual railway shop, just as food conservation becomes the problem of the individual housewife. The saving by any one family of two pounds of meat on certain days does not amount to anything in itself, but when ten million families save two pounds of meat each week the total is over a billion pounds per annum. Likewise, if every one of America's factories saved just 1 per cent of their fuel. the total savings would be 5,000,000 tons. This year the war requires at least eight million more tons of coal than were taken from the earth last year. Mine operators and miners are speeding their work but cannot supply all the extra tons needed. There is a limit to production because there is a limit to labor and to transportation. Many million tons of the added war requirements must be saved in the homes, apartment houses, hotels, churches, schools, stores and railroad repair shops and power houses.

Mr. McAdoo's Figures.

Since the leading railroads came under Government control Mr. McAdoo asserts that the number of tons of revenue freight carried has increased 8.9 per cent; the number of freight cars in service, 5.1 per cent; the number of tons hauled per train, 6.9 per cent and the average carload has been increased 14.4 per cent.

Under Federal control the number of railroad officials drawing salaries of $5,000 a year or over has been reduced by 400 and $4,615,000 a year has been saved. The expenses of the law department have been reduced $1,500,000 a year. By the consolidation of ticket offices, and the abandonment of competition, it is estimated that $23,566,633 will be saved. And of this amount, $7,000,000 will be saved on advertising bills.

Importance of Lubrication.

Have you ever thought that not a single one of the ships, aeroplanes, tanks, motor cars, guns or shells for Uncle Sam's Fighting Forces could be produced if it were not for the little drops of oil which lubricate the vast machinery used for their manufacture? We have all read about the marvelous feats of shipbuilding and the enormous steel plants and rolling mills which are making the plates for the hulls, but except for those who are directly identified with the mills themselves there are very few people who have heard about the lubricants that keep the bearings and the gears of these massive machines moving or the manner in which these lubricants are used.

This explains why Germany feels the pinch on lubricants. It has been said that there are engines and cars owned and operated by the Central Powers, which are standing still and out of service for want of lubricants. That is why fats of all kinds are precious in German eyes to-day. Every drop of oil saved here is a distinct gain for the Government in the war.

Air Brake Department

Spring Type Pressure Retaining Valve—Questions and Answers

The value of a brake cylinder pressure retaining valve is recognized to such an extent that all freight cars offered in interchange must be equipped with this device, according to a ruling of the M. C. B. Association. An analysis of the requirements imposed upon such a device indicates that a uniform blow down of brake cylinder pressure is essential, regardless of the size of the brake cylinder.

In an effort to provide an efficient retaining valve the Westinghouse Air Brake Company has developed a spring type pressure retaining valve to replace the former weight type, the limitations of which are quite well known. As the illustrations show, the valves are furnished in either single or double pressure designs, and have a range wide enough to cover all sizes of cylinders for either passenger or freight service. The double pressure valves are arranged to retain brake cylinder pressures of 10 to 20 lbs., 15 to 30 lbs. or 25 to 50 lbs. as required, the high and low pressure positions being shown by the lettering on the valve body. The advantage of the use of spring type retainers is summed up in the following particulars:

FRONT AND SIDE VIEWS OF THE SPRING TYPE OF PRESSURE RETAINING VALVE.

It is a means of securing definite and uniform rate of blow down for the various sizes of cylinders, in order to assist in insuring uniform brake action. Either the pressure retained or the rate of blow down may be modified to suit conditions of service by merely changing the spring on the one hand and the top cap on the other. The elimination of possible valve seat wear occasionally developed in the weight type of retainer due to the vibration of the weights caused by rough riding of large capacity cars when empty. Wear of the valve seat and efficiency of the device is not affected by inclination of the valve from a vertical position. The vent port is located where it will not be affected by dirt. The valve seat is raised so as to avoid lodgment of dirt between the valve and seat. Elimination of bent valve stems sometimes found in weight type of retainers due to rough handling. A large key bearing is provided so as to prolong the period before wear requires repairs. The double pressure type is designed to eliminate the leakage occasionally found in the weight type when in its high pressure position, due to dirt preventing the lifting pin from seating.

A tapped exhaust opening is provided which is arranged for a gauge connection thereby providing a convenient method for testing brake cylinder leakage without the necessity for disconnecting the retainer pipe at the triple valve. This is a distinct feature in itself of sufficient importance to warrant the new design. Since it is true that the whole function and purpose of the air brake system is to deliver and maintain certain air pressures in the brake cylinder, the importance of guarding against leakage from the brake cylinder and retaining pipe must appeal strongly to all railroad officials and particularly to air brake men. The ability to check this leakage and establish the requisite pressure quickly when it exceeds a predetermined permissible maximum is, therefore, a feature of much broader economic significance than a mere casual consideration of the retaining valve might indicate, especially in steep grade and level road service.

It is generally understood that a retaining valve should receive attention at the same time that the brake cylinder and triple valve are cleaned, and it and the retaining valve piping should be tested when the brake cylinder and triple valve are tested on shop repair tracks without cleaning. The following table gives a rate of leakage that should not be exceeded, it being understood that the brake cylinder leakage per minute from

Type of retaining valve.	Position of handle.	Cylinder pressure.	Leakage in one minute. Cylinders cleaned.	Leakage in one minute. Cylinders not cleaned.
15 lb. single pressure both spring and weighted	....	10 lbs.	5	7
15-30 double pressure weight type........	....	20 lbs.	6	10
15-30 double pressure spring type........	High	20 lbs.	6	10
	Low	10 lbs.	5	7
25-50 double pressure weight type........	....	40 lbs.	8	13½
25-50 double pressure spring type........	High	40 lbs.	8	13½
	Low	15 lbs.	5½	9

cylinders that have not been cleaned, does not exceed 12 lbs. per minute. The weight type of retaining valve is to be tested by screwing a gauge into the exhaust port of the triple, opposite to the retaining valve pipe connection.

The table is one that is employed by a certain railroad system and is resulting in a considerable improvement in freight car brake efficiency. It is also specified that the exhaust port of the spring type of retaining valve for freight service should be cleaned with a No. 54 drill for 8-in. equipment and with a No. 52 drill for 10-in. equipment.

Questions and Answers.

Locomotive Air Brake Inspection.

(*Continued from page* 323, *October*, 1918.)

530. Q.—What would an air gauge register on a cylinder with 30 lbs. absolute pressure at ⅞ of the way?

A.—120 lbs. or 105 lbs. gauge pressure.

531. Q.—When pumping against 100 lbs. air pressure with a 9½-in. pump, how near is the piston to the end of the cylinder when the discharge valve is lifted to admit pressure to the main reservoir?

A.—Within 1⅛ ins.

532. Q.—How do you calculate this?

A.—By ⅞ of a 9-in. stroke.

533. Q.—How near is the air piston of the 11-in. pump to the end of its stroke before the discharge valve can be lifted against 100 lbs. air pressure?

A.—It must travel ⅞ of a 12-in. stroke or will be within 1½ ins.

534. Q.—Is this assumption applicable to the low pressure cylinders of the compound or duplex compressors?

A.—Not exactly in the same manner, as air is then discharged into the high pressure cylinder from the low pressure, instead of into the main reservoir direct.

535. Q.—What determines the capacity of a single stage compressor?

A.—The speed in strokes per minute, the air pressure it is being operated against, and to a certain extent, the pressure of the atmosphere.

536. Q.—What is meant by the term "one atmosphere" as used in connection with air brake operation?

A.—A cylinder or reservoir containing air at atmospheric pressure.

537. Q.—How are the number of atmospheres of a given air pressure per square inch determined?

A.—By dividing gauge pressure, plus atmospheric pressure, by the pressure of the atmosphere.

538. Q.—Give an example.

A.—At 110 lbs. gauge pressure, there are 124.7 lbs. absolute pressure at the sea level. 124.7 divided by 14.7 equals 8.5 or in 110 lbs. gauge pressure there is contained 8½ atmospheres.

539. Q.—Can this be made somewhat clearer?

A.—If the reservoir has a capacity of one cubic foot, and the pressure is 110 lbs. it contains 8½ cb. ft. of free air or air at atmospheric pressure.

540. Q.—What is generally meant by the term "capacity of the compressor" or "air pump capacity"?

A.—The size of the compressor or the number of compressors used on a locomotive.

541. Q.—What is meant by "efficiency of the compressor"?

A.—The general condition of the pump or compressors.

542. Q.—What is wrong when a compressor is in what is termed a poor condition?

A.—There is leakage through or past some part of the air or steam end of the pump, which reduces its efficiency, or capacity to compress air.

543. Q.—At what points do these leaks occur in the air cylinder?

A.—Past the air piston packing rings, back from the main reservoir through the discharge valves or from the cylinder to the atmosphere past the receiving valves or from any stuffing box, gasket or any other leak of the atmosphere.

544. Q.—Is there any other disorder that can prevent the delivery of the proper amount of compressed air to the main reservoir?

A.—Obstructions in the ports, passages or in the air strainer.

545. Q.—How does the condition of the steam end affect the volume of air delivered to the main reservoir?

A.—By reducing the speed of the compressor.

546. Q.—Does the piston speed influence the amount of leakage that may be passing the air piston packing rings?

A.—Yes; the faster the piston speed, the less time that will be permitted for leakage to exist.

547. Q.—At what time is leakage past the packing rings of the most consequence?

A.—When the compressor piston is near the end of its stroke.

548. Q.—Why?

A.—Because the air pressure in the cylinder is higher near the end of the piston stroke.

549. Q.—How does this affect the piston speed?

A.—It tends to slow it up.

550. Q.—Why?

A.—Because the higher the air pressure, the more work that it is necessary for the steam end to do.

551. Q.—How is it proved that more work is done at the ends of the stroke than in the center of the cylinder?

A.—By the wear of the cylinders, which is always greater at the ends than in the middle of the cylinder.

552. Q.—How can leakage in the steam cylinder or steam valve mechanism generally be quickly discovered?

A.—By a blow or waste of steam at the exhaust connection.

553. Q.—Is there anything besides leakage in the steam end that can reduce the speed of the compressor?

A.—Yes; restrictions in the ports or passages or in the steam supply.

554. Q.—How does the construction of a compressor vary its efficiency?

A.—Through the amount of, or percentage of, a cylinder full of free air that can be delivered to the main reservoir on each stroke.

555. Q.—How is this governed by construction?

A.—In the location of discharge valves and intermediate valves, and the clearance of the pistons at the ends of the cylinders.

556. Q.—What is the effect of increased clearance space between the air piston and cylinder heads?

A.—It permits the compressed air that remains in the ends of the cylinder, to expand back into the cylinder as the piston movement reverses and thus take up space that should be filled with free air, through the air strainers.

557. Q.—How does location of valves enter into this efficiency of the compressor?

A.—The greater the distance from the air piston to the delivery valve, the greater the amount of compressed air that will not be discharged from the cylinder.

558. Q.—Does this also apply to the space between the receiving valves and the air piston?

A.—Yes, in the same manner.

559. Q.—Then a compressor may have what may be termed different capacities?

A.—Yes, it has a theoretical capacity and an actual capacity.

560. Q.—What is meant by the theoretical capacity?

A.—The capacity of the air cylinder that receives free air in cubic inches less the thickness of the piston, or the area multiplied by the length of the piston stroke.

561. Q.—What other term is sometimes used to designate the capacity of the receiving cylinder to hold free air?

A.—Piston displacement.

562. Q.—How is the actual capacity of the compressor found?

A.—By ascertaining the number of cubic feet of free air actually compressed under some particular condition.

563. Q.—What is meant by "per cent. of efficiency" in air compressors?

A.—The percentage of a cylinder full of free air that is actually delivered on each stroke of the compressor.

564. Q.—Or in figures?

A.—The actual number of cubic inches of free air compressed per stroke, divided by the piston displacement.

565. Q.—Which type of compressor

manifests the greater per cent. of efficiency?

A.—The cross compound compressors.

566. Q.—Why?

A.—Because of a better location of air valves already mentioned and a reduced clearance space for the pistons and through the fact that the low pressure air piston does not work against a higher air pressure than 40 lbs. per square inch.

(To be continued.)

Train Handling.

(Continued from page 324, October, 1918.)

542. Q.—What advantages have the ET and LT brake equipments over former types?

A.—Locomotive and tender brake cylinder pressure will be maintained at a constant figure regardless of unequal brake piston travel and brake cylinder leakage, up to the capacity of the air compressor and the point at which the brake pistons come in contact with the non-pressure heads of the cylinders.

543. Q.—What are the principal advantages from a view point of manipulation?

A.—The locomotive and tender brake can be operated entirely independent of the train brakes, and the pressure can be graduated out of, as well as into, the brake cylinders with either one of the brake valves.

544. Q.—What are the essential parts of these equipments?

A.—An air compressor, a governor, a main reservoir, two brake valves, two duplex air gauges, two pressure controllers, suitable brake cylinders, and the usual piping, cut out cocks and hose connections.

545. Q.—What other advantages are there in the way of brake apparatus used?

A.—Less brake apparatus is required for the improved features, and but one size of operating valve and reservoir is required.

546. Q.—Is it adaptable to all classes of service?

A.—It is used in any passenger, freight or switching service without any special change in adjustment.

547. Q.—What is the name of the pipe leading from the dome or bridge pipe to the air compressor?

A.—The air pump steam pipe, or steam admission pipe.

548. Q.—What part of the equipment is in this pipe?

A.—The air pump governor.

549. Q.—Has it any other pipe connection to its steam portion?

A.—Yes, a drain or waste pipe.

550. Q.—What is the name of the pipe leading from the steam cylinder of the compressor to the locomotive cylinder saddle or the front end?

A.—The air pump exhaust pipe.

551. Q.—What is the name of the pipe leading from the air pump to the first main reservoir?

A.—The air pump discharge pipe.

552. Q.—Have the steam cylinders any other pipe connections?

A.—Sometimes steam cylinder waste or drain pipes.

553. Q.—Have the air cylinders any other pipe connections?

A.—Sometimes oil pipes leading from the locomotive lubricator.

554. Q.—What is the name of the pipe connecting the main reservoirs?

A.—The connecting pipe.

555. Q.—The name of the pipe connecting the last main reservoir and the automatic brake valve?

A.—The main reservoir pipe; usually termed the reservoir pipe.

556. Q.—The name of the pipe connecting the automatic brake valve and the feed valve?

A.—The feed valve pipe.

557. Q.—Is the feed valve pipe an essential of the equipment?

A.—No, the feed valve may be attached to the automatic brake valve bracket and require no pipe connections.

558. Q.—The pipe connecting the reducing valve and independent brake valve?

A.—The reducing valve pipe.

559. Q.—The pipe connecting the automatic brake valve, the driver brake cylinder operating valve and the angle cocks at the front and rear end?

A.—The brake pipe.

560. Q.—The pipe connecting the driver brake operating valve and the brake cylinders?

A.—The brake cylinder pipe.

561. Q.—The pipe connecting the feed valve pipe, or feed valve pipe port, in the brake valve pipe bracket, and the excess pressure governor top?

A.—The excess pressure pipe.

562. Q.—The pipe connecting the brake valve bracket and the lower connection of the excess pressure governor top?

A.—The excess pressure operating pipe.

563. Q.—The pipe connecting the maximum governor top with the main reservoir?

A.—The governor pipe.

564. Q.—The pipe connecting the main reservoir and air gauge?

A.—The reservoir gauge pipe.

565. Q.—The name of the pipe connecting the brake pipe and air gauge?

A.—The brake pipe gauge pipe.

566. Q.—The pipe connecting the equalizing reservoir and air gauge?

A.—The equalizing reservoir gauge pipe.

567. Q.—The pipe connecting the brake cylinders and the air gauge?

A.—The brake cylinder gauge pipe.

568. Q.—The pipe connecting the equalizing reservoir and the brake valve?

A.—The equalizing reservoir pipe.

569. Q.—The one connecting the main reservoir pipe and the distributing valve reservoir?

A.—The distributing valve supply pipe.

570. Q.—The pipe connecting the independent brake valve and distributing valve?

A.—The release pipe.

571. Q.—The one connecting the distributing valve and both brake valves?

A.—The application cylinder pipe.

572. Q.—The one connecting the brake valves?

A.—The release pipe branch pipe.

573. Q.—The name of the pipe connecting the control valve of the LT equipment with the automatic brake valve?

A.—The control valve release pipe.

574. Q.—The one connecting the control valve and both brake valves?

A.—The control reservoir pipe.

575. Q.—The one leading from the straight air brake valve to the double check valve?

A.—The straight air pipe.

576. Q.—How do the names of the rest of the piping of the LT equipment compare with the ET?

A.—They are practically the same.

577. Q.—How are the pipes leading to the distributing valve or control valve or to the automatic brake valve from the main brake pipe referred to?

A.—As brake pipe branch pipes, specifying the part the branch leads to.

578. Q.—The pipe leading from the reservoir pipe to the pressure controllers?

A.—As the reservoir branch pipe.

579. Q.—What is the difference between the independent brake of the ET and the straight air brake of the LT equipment?

A.—With the independent brake the distributing valve controls the flow of air to and from the brake cylinders, with the straight air it flows direct from the main reservoir through the straight air brake valve and double check valve to the cylinders.

580. Q.—How should an air compressor be started?

A.—With the drain cocks in the steam cylinders open and with a very light throttle or at a very slow speed.

581. Q.—When should the lubricator be started to feed the steam cylinders?

A.—As soon as the condensation has worked out of the cylinders and the drain cocks have been closed.

582. Q.—How should it be fed?

A.—With 10 or 15 drops to start with, and thereafter the feed should be regulated to from one to two drops per minute per cylinder.

583. Q.—When should the air cylinders be lubricated?

A.—As soon as the compressor is started.

584. Q.—In what quantity?

A.—8 or 10 drops per cylinder.

585. Q.—Under what condition?

A.—While the compressor is working at a fair rate of speed against a low air pressure and with very hot oil.

586. Q.—What kind of oil?

A.—Valve oil.

587. Q.—Why should the oil be hot and the speed at a fair rate?

A.—So that the oil may be scattered around in the cylinder and properly lubricate it.

588. Q.—Can this be done if the air pressure is high and the speed slow?

A.—Not without using an excessive amount of oil and flooding the cylinder.

(*To be continued.*)

Car Brake Inspection.

(*Continued from page* 325, *October*, 1918.)

512. Q.—What is the effect of such leakage?

A.—If from the brake pipe it is a waste of air and tends to apply the brakes with a greater force than is desired, or rather tends to take the control of the brakes away from the engineman and if from the auxiliary reservoir it tends to release brakes after being applied, that is, the brake with the defective valve, and thereafter cause a drain on the brake pipe.

513. Q.—What is the effect of a leaky graduating valve?

A.—It fails to stop the flow of air from the auxiliary reservoir after the triple valve has assumed lap position and under certain conditions may result in a release of the brake.

514. Q.—In what way can it cause the brake to release?

A.—By making a reduction in the pressure in the auxiliary reservoir.

515. Q.—If the triple valve is in perfect condition will the brake release even if the graduating valve is leaking?

A.—No, as the triple valve may then be expected to move toward its release position gradually, the slide valve will eventually stop with the service port closed by the slide valve seat before the exhaust port can open.

516. Q.—Will the leaky graduating valve cause a blow at the triple valve exhaust port?

A.—Not unless it is of the slide valve kind, used in modern types of triple valves.

517. Q.—How can it sometimes be known whether a leak is from the emergency valve without an examination?

A.—By the buzzing sound accompanying the leak at the exhaust port.

518. Q.—What causes this buzzing noise?

A.—The check valve rising and falling very rapidly in supplying the leakage.

519. Q.—What causes a triple valve to fail to release?

A.—Either the brake pipe pressure has not been increased sufficiently to accomplish the release, the auxiliary reservoir has been charged to a higher pressure than that carried in the brake pipe or brake pipe pressure has passed the triple valve piston packing ring and has charged the auxiliary reservoir equal to the brake pipe, without moving the triple valve.

520. Q.—What causes a brake to fail to apply, with a light brake pipe reduction?

A.—Either excessive friction in the triple valve, leakage past the packing ring or the triple valve piston and slide valve may have moved, but the pressure has escaped from the brake cylinder through the leather or gasket.

521. Q.—What does a failure to release this sometimes result in?

A.—A slid flat wheel.

522. Q.—What defects in wheels and trucks are sometimes responsible for slid flat wheels?

A.—Wheels not bored centrally; improperly mounted on axle; wheels not perfectly round; wheels warped; unevenly chilled; improperly hung brake beams; improper length of brake beam hangers.

523. Q.—What defects of the car brakes contribute toward bad results?

A.—Unequal piston travel; brake pipe leakage; stopped up retaining valve; wrongly used triple valve; imperfect triple valve repair work; leaky emergency valve or check valve case gasket; wrongly used triple valve piston; leaky triple valve piston packing ring; too thin brake shoes.

524. Q.—What lack of observation or inspection may be responsible?

A.—Starting trains with brakes applied is the most prolific cause; retaining valve turned up; switching cars with brakes set; ice frozen in brake rigging; brake beams wedged with shoes against the wheels; clubbing down hand brakes with air brakes applied.

525. Q.—How will improper manipulation contribute?

A.—Too long a time with the brake valve in release position; allowing insufficient time for a release of brakes; failure to kick off brakes after a re-application; failure to apply brake in a manner to conform with slack conditions in train.

526. Q.—Are there any defects of the engine equipment that may result in slid flat wheels on cars?

A.—Yes, defective triple valves on engine; leaky brake cylinder; defective feed valve; no excess pressure; main reservoir full of water.

527. Q.—Is there any other prolific cause of slid flat wheels?

A.—Yes, due to slack action in trains not being properly controlled (not necessarily a fault in the manipulation) the car bodies are accelerated at a faster rate than at which the car wheels can revolve with the brake shoes retarding them and in this manner the adhesion of the wheel to the rail is broken.

528. Q.—What is the effect of a leaky check valve if found in the triple valve?

A.—It will have no effect until the brake pipe pressure is lower than the point of equalization of the brake cylinder and auxiliary reservoir, thereafter it will leak brake cylinder pressure back into the brake pipe.

529. Q.—What occurs if for any reason the brake pipe pressure reduces at a faster rate than that at which the auxiliary reservoir pressure can flow through the service port into the brake cylinder?

A.—The triple valve will travel its full stroke and assume emergency position.

530. Q.—What defects of the triple valve will cause this action?

A.—The disorders that will contribute are: A restricted service port; oil or moisture on the slide valve; a dirty or gummed up triple valve piston; excessive friction in the movement of the slide valve; a tight piston or ring; a partly closed feed groove; piston making a tight seal on the slide valve bushing; gum on piston bevel; slide valve spring catching in bushing; a weak graduating spring; a broken graduating spring; under some conditions a very short piston travel.

531. Q.—How does oil on the slide valve contribute?

A.—By making a tight seal around the edges of the slide valve and positively excluding any leakage to the under side of the slide valve which allows the entire pressure per square inch of the auxiliary reservoir pressure to be effective on the slide valve, whereas if there was a slight amount of leakage or percolation of air to the under side of the slide valve the valve would tend to be balanced and would be comparatively free in its movement.

532. Q.—How does the partly closed feed groove contribute?

A.—On a slow rate of brake pipe reduction through leakage, the triple valve piston and graduating valve may be moved to close the feed groove with the end of the piston being in contact with the slide valve, but the brake pipe reduction being insufficient to cause the further movement of the slide valve or the triple valve pistons where the feed grooves are open and free to permit of a certain amount of back flow into the brake pipe, this triple valve with the partly closed feed groove will have assumed a position in which the piston engages the slide valve with the auxiliary reservoir pressure bottled up, and if a brake pipe reduction is made at this time the valve may jump into the quick action position. On the other hand if the feed groove had been open, the piston would not have been moved until a positive brake pipe reduction had occurred and as a result it would have moved against the slide valve with sufficient force to dislodge it and move it promptly to service application position.

(*To be continued.*)

Forty-Ton Steel Flat Car for the Canadian Government Railways

The Eastern Car Company of New Glasgow, N. S. Canada have lately built a number of steel 40-ton flat cars for the Canadian Government. These cars were specified to be of ample strength to carry the load designated 80,000 lbs., in addition to the tare weight of the car with an increase of 15 per cent. of the load, if need be. The forgings are of open hearth steel. The centre sill is open hearth steel plates 5-16 ins., thick spliced at the centre, 30 ins., deep and strengthened with top outside angles, 3½x3½x5-16 ins., and having bottom inside and outside angles, 3½x3½x7-16 ins.

The centre sill cover plate is 24x⅜ ins., open hearth steel 18 ft., long at the centre, and 24x¼ ins., at ends; two plates, each about 12 ft., 6 ins., long, form the end sections. The intermediate sills are open hearth Z-bars 3 ins., high and running 6.7 lbs., to the foot of length. Each Z-bar is made in one length. The side sills are open hearth ship channels 10 ins., deep, in one length and running 20 lbs., to the foot. The end sills are of similar make, only they weigh 21.8 lbs., to the foot and are also 10 ins. deep. The body bolsters are of the built up type, combined with the other frame.

The diaphragms between sills are open hearth steel shapes, pressed to shape ¼ in., thick. The top cover plates are each 15x7-16 ins. The bottom tie plates are 15x9-16 ins. The floor stringers are of yellow pine or British Columbia fir, sides 4x4 ins., the centre being 3¼x4 ins., and 3⅜x4 ins., running the full length of the car. The centre stringers are bolted with ½ in., bolts, and side stringers use ¾ in., bolts. The flooring is of spruce 9 ft., long, 2⅜ inc., thick, with 5, 6 or 7 ins., face width, and carefully ship-lapped. Each board is nailed to the stringers with eight steel barbed wire nails 5 ins., long, and bolted to the intermediate sills with ½ in., round head bolts, 3½ ins., long. The end boards are bolted to the end sills with four ½ in., bolts and four nails to each board.

The draw gear is the Miner twin spring type with yokes 1¼x5 ins., forged from solid billets. The draw bars are Penn. with ⅝ in., shank 6½ ins., but, with 5x7 ins., shank and with key slot, buffing lugs, and cored holes. The couplers are equipped with "Acme" uncoupling device, operated from both sides of the car.

A yellow pine board 1⅛x9x12 ins., is bolted with four ⅝ in., bolts to the outside of the side sills on each side of the car, and to this 13 open hearth steel stake pockets are secured on each side.

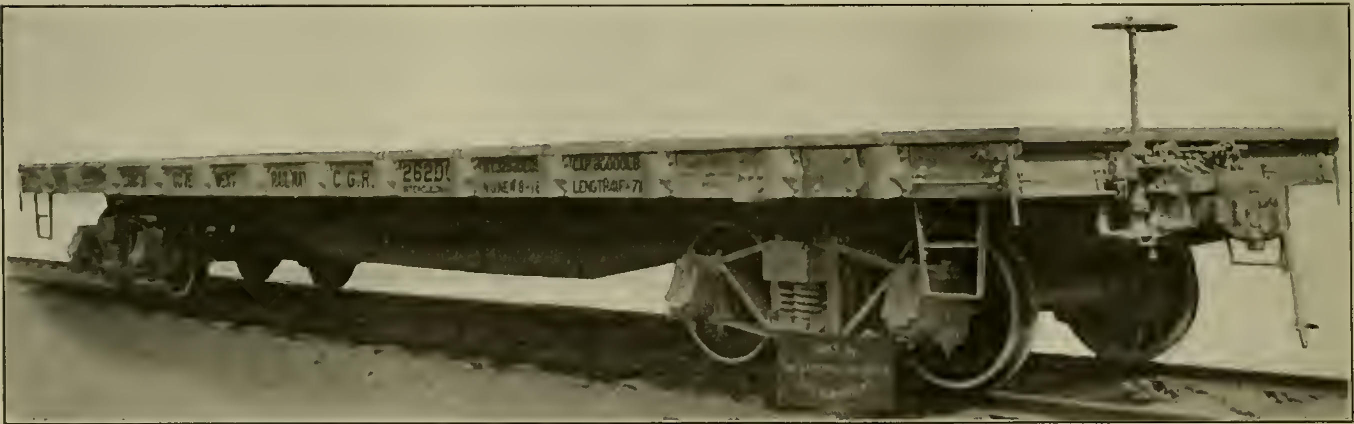
The Westinghouse standard automatic brake equipment Schedule K. C. 812 with J-M brake cylinder expander rings is used. The general arrangement and details conform to the M. C. B. requirements. Braking power 60 per cent. of the light weight of car based on 50 lbs., cylinder pressure. M. C. B. standard air brake hose.

At one end of car, arranged to drop, is a hand brake wheel of malleable iron, and of 7-16 in., wrought iron or steel. The car trucks are of the diamond pattern. The diamond trucks are for 4 ft., 8½ ins., track, and have a wheel base of 5 ft. 4 ins. The size of the journals are 5x9 ins., and the wheels are of ordinary chilled from 33 ins., in diameter. Heads of journal box bolts and column bolts rest on malleable iron washers

The arch bars are open hearth steel. The top bars measure 1½x4½ ins. The bottom bars are 1½x4½ ins. The tie bars are ⅝x4½ ins. Column bolts are 1⅝ ins., diameter. Journal box bolts 1⅛ ins., diameter, of O. H. steel, and are fitted with single nuts and grip nuts. The M. C. B. standard, 5x9 ins., journals are used. Journals are roller finish, and this includes the shoulder from the wheel, and the collar.

The bolsters are Simplex for these 40-ton cars. The side bearings are spaced 52 ins., centre to centre. The centre plates are cast steel, riveted to the bolsters. The spring plank is formed of steel channels, one to a truck 13 ins., wide and weighing 32 lbs., to the foot, riveted to columns with 1 in., rivets.

A few of the general dimensions of the car are as follows:—Length between end sills 41 ft. Length over striking plates 42 ft., 2 ins. Width over side sills 8 ft., 10 ins. Width over floor 9 ft., 10 ins. Width over stake pockets 9 ft., 7¾ ins. Height from rail to centre of coupler 2 ft., 10½ ins. Height from rail to top of floor 4 ft., 2 13-16 ins., and from centre to centre of bolsters 30 ft. These cars are built according to specifications of the Superintendent of Canadian Government Railways, Mr. Geo. R. Joughins.—Moncton, N. B.



STEEL FLAT CAR, 40 TONS CAPACITY, FOR CANADIAN GOVERNMENT RAILWAYS.

The Future of the U. S. A.

The German war has taught us many things, and it has forced us to take a wide, more international view of things. The era of the purchaser beginning at the door of the producer will pass, and the producer must prepare for it. He must cultivate new demands for his products or else curtail production. It is up to him, and now is none too soon to begin. Railway supply houses as well as other manufacturers come under this rule. They must widen their field, and let the public know that they have widened it. They must say what they have to sell and tell everyone all about it.

Electrical Department

What Is the Meaning of Split Phase? The Electro-Pneumatic Brake

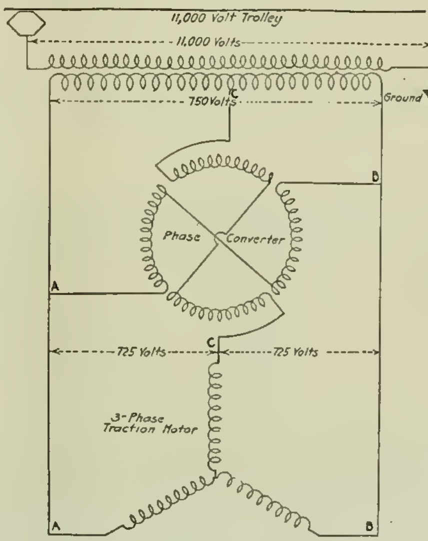
In our article of September on electric locomotive characteristics we showed certain curves and referred to the split phase locomotive. A few words of explanation may not be out of place as to just what is meant by "split phase."

The split phase type of electric locomotive is that used by the Norfolk & Western Railroad. In order to better appreciate the choice of this type of locomotive for the Norfolk & Western we may point out the operating conditions which any electric locomotive would have to meet on this railroad.

The train weights are great, varying from 3,000 tons to as high as 4,000 tons, although the average train is about 3,300 tons. It is therefore necessary to have part of the motive power at the rear of the train in order to avoid excessive strain on the draft rigging of the cars at the front. Formerly the trains handled by steam required three steam locomotives of the Mallet type; two at the head and one at the rear as a "pusher." With electric operation and flexibility of design and the possibility of utilizing heavy starting tractive effort, it is possible to eliminate one steam locomotive so that two electric locomotives can do the work of the three engines using steam.

The trains are of such great length that there is difficulty in signaling from the front locomotive to the rear locomotive when a start is to be made, so that the locomotives are subject to treatment which would be considered impossible for ordinary service. For example, the rear locomotive may receive a signal to go ahead one full minute before the leading locomotive has started and taken up the slack. The rear locomotive during this period will stand still with power on, exerting full tractive effort in an endeavor to start the train. This condition may easily come about when the rail is slippery and the first locomotive does not "take hold" or when the brakes do not release wholly. We know that with a steam locomotive the live steam can be kept in the cylinder as long as desired and the locomotive be kept exerting maximum tractive effort, without any harm to the locomotive. We know, from the preceding two articles, that the electric locomotive has a time limit for the current. All the time that the electric locomotive, in the above case, is standing still, current is flowing and the motor is heating up. Operating conditions of this kind would be exceedingly hard on a commutating motor—i. e., a motor with a commutator. Again an engineering study of service conditions showed that an engine of constant speed would be best for this kind of work. This would mean the three phase motor, which has a constant speed under all conditions of load and moreover has no commutator.

The three phase motor as the name implies runs on three phase electric current, and this in turn is carried over three wires. There are three phase electric locomotives, operating abroad, and there is also one three-phase installation in this country on the Great Northern Railroad. With three phase current, as mentioned above, three lines



DIAGRAMMATIC CONNECTIONS FOR PHASE CONVERTER AND TRACTION MOTORS—SPLIT PHASE LOCOMOTIVE.

are required, and in the case of the three phase electrifications, the running rails are used as one wire, and two overhead wires are used, insulated from each other. On straight track these two wires can be easily maintained in alignment, but at cross wires, switches, turnouts, etc., it is difficult to keep the wires in alignment, and the special means employed are not very satisfactory. Provisions must be made so that the power will not be taken to the locomotive which may be pulling a heavy train, but wires must not be placed so that the trolley on the locomotive does not "short circuit" two wires of different phase.

If it was possible to use one overhead wire of high voltage, alternating current, like the New Haven electrification, and at the same time to use the three phase motors, an ideal electrification would result for service as on the N. & W. There are no complications involved in the stringing of one overhead high tension wire and the three phase characteristics are ideal for these conditions.

This has been done in the case of the N. & W. electric locomotives. Three phase induction type motors, with wound secondaries (rotors) are mounted on the trucks, and single phase 11,000 volt alternating current is fed into the locomotive from one overhead wire.

This single-phase current must then be changed into a three-phase current to operate the motors, and this is done inside the locomotive as described below. It is this arrangement which has been called "split phase."

Our diagram shows the diagrammatic connections inside the locomotive. The single phase current is fed through an oil-type circuit-breaker to the main transformer. The phase converter is a rotary piece of apparatus and is connected to the low tension side of the transformer, and is the apparatus which changes the single-phase current to the three-phase form. The phase converter operates constantly when the engine is in service.

The phase converter is a single-phase induction motor with a short-circuited, squirrel-cage rotor, or secondary and with two primary windings on the stator. One of these windings is connected across the secondary of a transformer, and when the rotor is running there is generated in the second winding an emf of 90 degrees phase displacement from that of the secondary of the stationary transformer. The use of this device in railway work is so novel that a review of the fundamental principle may be of interest.

Any polyphase induction motor will operate as a single-phase motor on one phase of a polyphase circuit if the motor is brought up to its "pick-up" speed by some external or internal means. Thus if one wire of an operating two-phase motor is broken, leaving but one phase in action, it will continue to run. Moreover, a voltmeter, applied to the open primary winding will show a voltage practically equal to that in the line from which it was disconnected. The motor is, therefore, performing two functions, motor and phase transformer or converter.

If a primary lead is opened with the

motor running, there is only single-phase magnetizing current available. By transformer action, however, this produces in the rotor conductors surrounding the magnetic field a single-phase secondary current. At the same time the motion of the rotor conductors in the single-phase magnetic field produces emf and another current phase displaced 90 degrees from the first. Thus there are two rotor currents in phase quadrature and in different parts of the rotor winding. The current generated by the speed acts as a second mgnetizing current and, combined with the magnetizing current from the line, produces a rotating field, just as when the machine was operating as a two-phase motor. In this field the rotor produces torque and will carry a mechanical load satisfactorily.

This rotating field cuts the open primary winding of the motor and generates in it an emf in quadrature with the line emf. From this winding, current can be drawn as from the secondary winding of any transformer. It and the line current, taken together, form a two-phase current. A three-phase current can be generated in a similar manner.

Reference to the line diagram shows a two-hole phase converter with the rotor omitted, as the function of this is induction only, as explained. One terminal of the quadrature winding is connected at C, at or near the centre of the secondary transformer winding. The converter winding is so designed that the voltage between C and C will be sufficient to produce equal voltages between A and C, and between C and B, and also between B and A. With this arrangement only a portion of the current used in the main motors is converted, as a large part comes directly from the main transformers. The single phase power is "split."

The Electro-Pneumatic Brake.

Electricity has been adapted to many features and used in connection with all kinds of apparatus. Why can it not be used in connection with the air brake, was a natural question, asked by the air brake man and the electrician. The brake is the most important feature of a railroad train, which improves its operation. Electricity can, and has been adapted to the air brake of the high speed subway trains in New York. The operation of the subway trains consisting of ten cars at a speed of 30 miles an hour and with a "headway" of 90 seconds, necessitated the use of a brake giving the maximum rate of retardation in emergency, and a rapid and accurate stop in "service," without shock.

A somewhat general impression prevails that the use of the electric control, increases the actual braking power, but this is not the case. The sole function of the electric control is to secure a simultaneous application of all brakes, regardless of the length of the train. It eliminates the time required for the ordinary brake application. With the electric control all the brakes are applied simultaneously, while with regular air control the brake pipe pressure must be reduced through the engineers' valve and considerable time is required for the pressure to be reduced at the end of the train. The first car receives the braking effect first, and each car in sequence until the last one. The electric control, with brakes on all cars applied, at the same time, permits braking rates up to the maximum without rough handling in long trains.

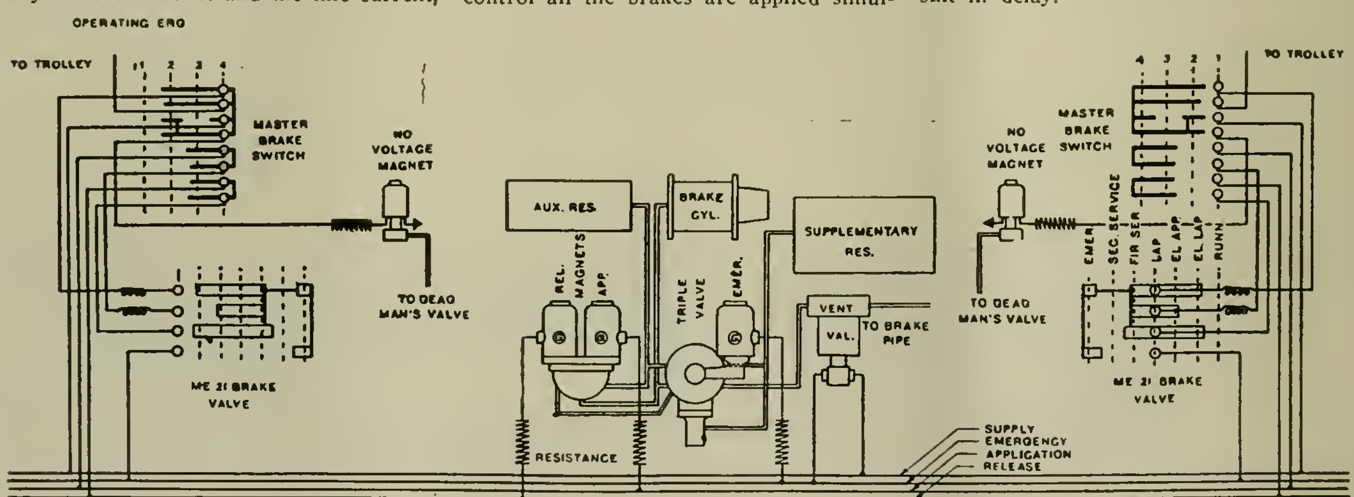
The value of the electric-pneumatic brake can be appreciated by a study of the time required to perform the various functions. First, There is a saving in reflex time of the brake application ("Reflex" time is the time from brake valve handle movement, to rise in brake cylinder pressure. It corresponds to "reaction" time which is the interval from sight to action in man. "Reflex" time is mechanical "Reaction" time, is nerve action time.) With the electric application the pressure is built up almost instantaneously, while with the pneumatic application a certain reduction in brake pipe pressure is necessary before pressure reaches the cylinder. The saving in time is 2 seconds. Second, There is a saving in time when brakes are released. With electric operation the release can be made in 5 seconds as compared with from 10 up to 17 seconds. The total saving is therefore from 7 to 14 seconds.

This time-element if of particular advantage when slowing down for signals, as in the New York subway. In slowing down for a signal it is as necessary to get the brake off as it is to get it on, under operating conditions, where "the second" is the unit of time schedule. The delay resulting from applying the brakes with electric control really mean in many cases, no necessity for applying brakes at all, because the signal may go to "clear" within the 2 seconds which are saved in the "reflex" time. Therefore, the total saving in initial delay of from 7 to 14 seconds may mean a final total of 14 to 40 seconds which would otherwise result in delay.

The electric circuits are shown in the cut. Trolley voltage is brought to the master brake switch of the brake valve at the operating end of the train. It is distributed at the will of the motorman to the application, release and emergency valve's magnets on each car. The brake control is connected between cars by electric jumpers. Thus when the application wire is engaged, all the application magnets throughout the train admit air to the cylinders. Resistance is placed in the circuits so as to cut the current down to approximately 1/5 of an ampere.

Referring to the diagram here, it will be noted that there are seven positions of the brake valve handle, namely Release or Running, Electric Lap, Electric application, Automatic Lap, First Service, Second Service and Emergency.

In release position, trolley, application, release and emergency fingers are all off the switch drum. On moving the brake valve handle to electric lap, the trolley and release fingers are joined by the switch



NO. 5—ELECTRO-PNEUMATIC BRAKE.

drum, and consequently the release magnets of the train are energized and the release valves closed. A further movement of the brake valve handle to application position brings the application finger in contact with the drum, thereby energizing the application magnets and applying brakes. Returning the handle to the electric lap position opens the circuit through the application finger and the application valves close and cut off a further increase of brake cylinder pressure. The release and trolley fingers being still in contact with the switch, whatever pressure is in the brake cylinders is held there in this position. On returning the handle to release position, the release magnets are de-energized and the brakes released. In all three of the above mentioned positions, the release port of the brake valve is open and communication between the feed valve and the brake pipe is maintained. Consequently the air which is drawn from the auxiliary reservoir for use in the brake cylinders is continuously replaced by air drawn from the main reservoir system through the feed valve and the brake pipe. Should the motorman thoughtlessly continue the movement of the brake valve handle beyond electric application position, the brakes would continue to apply if the cylinders had not already received their maximum pressure. This would also be the case even though he continued the movement to first service position, in which a small opening is made from the brake pipe to the atmosphere through the rotary valve, and the brakes would be applied automatically in the event of their not having been previously applied electrically. It will thus be seen that there is no possible danger of a careless motorman failing to obtain an application of the brakes, or losing an application already obtained electrically by moving the handle.

As each brake valve in a train is wired to the brake circuits through the train, as shown, and all break valves except the operating one are left in lap position when the handles are removed, it is necessary to provide means for cutting off the application and release fingers of these valves, as otherwise the brakes would always be applied electrically by them. Also the supply of current must be controlled entirely from the one point on the train so that should there occur any derangement of the brake circuits or electrical apparatus this part of the brake system can be instantly isolated and the train continue under control of the automatic air brake. Furthermore, owing to the close headway on which trains operate, it was considered necessary to have the brakes apply automatically whenever the supply of current for the electric control of the brakes is taken away from the motorman, through the blowing of fuses or any other cause, for otherwise he might attempt to "get" the brakes electrically when there was no current available and lose a few seconds before realizing he can only use automatic service portion of the brake valve.

Switcher for the Toledo & Ohio Central Railroad

Not long ago the American Locomotive Company built some eight wheel switching engines for the U. S. Railroad Administration which have been assigned to the Toledo & Ohio Central Railroad. These engines have 25 x 28-in. cylinders and 51-in. driving wheels. The weight on the drivers is 214,000 lbs. and the total weight of the engine is of course, the same. The tractive power, with a factor of adhesion of 4.19, is 51,000 lbs.

The tender which weighs 167,900 lbs. carries 16 tons soft coal as fuel and 8,000 gals. of water, this with the engine makes the total weight of the whole machine 381,900 lbs. The boiler is 78 9/16 ins. inside diameter and the steam pressure is 175 lbs. per sq. in. The tubes and flues are arranged for a superheater. The tubes are 15 ft. long, and there are 230 of the 2-in. size, and 36 of the 5½-in. size. The heating surface which is 2,717 sq. ft. in all is distributed as follows: Tubes, 1,796 sq. ft.; flues, 773 sq. ft., and the firebox contributes 130 sq. ft., the arch tubes give 18 sq. ft., and the superheater is rated at 662 sq. ft. The grate area is 47 sq. ft. and the boiler is supplied with a brick arch. The firebox measures 102⅛ ins. long and is 66¼ ins. wide.

The wheel base of the engine alone is 15 ft. the engine being a switcher without leading or trailing wheels, the rigid wheel base is the same. The total wheel base of engine and tender is 52 ft. 11½ ins. The engine has main valves of the piston type and the valves are actuated by the Walschaerts gear. Power gear is used for manipulating the reverse lever.

The headlights are electric, and there are two of them, one being placed on top of the smoke box in front of the smoke stack and another headlight is placed at the back of the tender. This tender is carried on two trucks (i. e. eight wheels) and is to all intents and purposes a road-engine tender. American driver brakes are on the truck while Westinghouse are used elsewhere. One 8½-in. cross compound air compressor is carried on the engine, and the main reservoirs, two in number are each 20½ x 102 ins. The grate is of the rocking type. The tender is of the water leg type and carries 8,000 gals. of water and 16 tons of coal. The engine presents a neat and businesslike appearance.

UNITED STATES GOVERNMENT DESIGN 0-8-0 TYPE SWITCHER FOR THE T. & O. C.
C. Bowerson, Mast. Mech. American Loco. Co., Builders.

Hose Mounting and Hose Clamping Machines

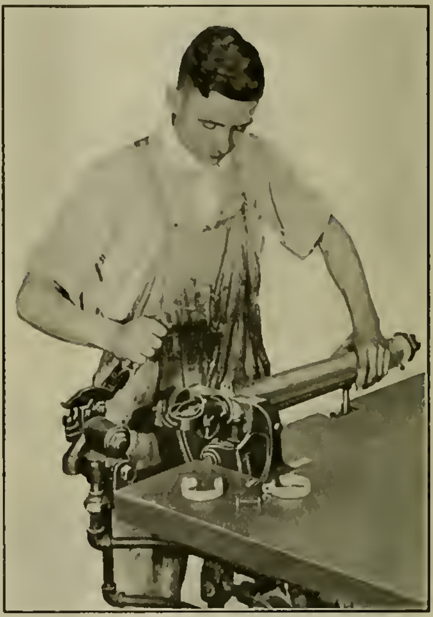
DESIGNED BY THE WESTINGHOUSE AIR BRAKE COMPANY

The Westinghouse Air Brake Company some time ago designed and developed for use in its Wilmerding factory, air-operated machines for mounting and clamping fittings into air brake hose. While the company has not heretofore attempted the manufacture of these devices, except for its own needs, it has recently arranged that the machines can be procured on order, either as complete outfits, or merely such details as are not obtainable from existing railroad material. Most of the details can be obtained from air brake stock, in which case repair shops could build their own machines, with exception, possibly, of especially designed parts. These special parts can either be obtained from the company or made by the railroads to blueprints which the company will be pleased to furnish on request. These machines have proved highly efficient and great labor savers.

AIR-OPERATED MACHINE FOR FORCING COUPLING HEADS AND NIPPLES INTO AIR HOSE.

The hose mounting machine consists of a frame on which is mounted a hand-operated clamp, designed to grip the hose throughout the greater part of its length, so as to hold it rigid while the coupling or nipple is being applied. The compressed air cylinder, with piston and rod, drives the fitting into the hose. An operating valve for controlling admission and exhaust of air from the cylinder and accessories, completes the machine. The piston rod of the cylinder is adapted to the special heads used for mounting both the coupling and the nipple. These heads are removable so that both nipple and coupling can be mounted on a single machine, although not at the same time.

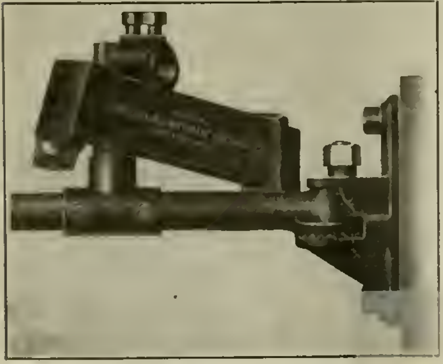
The hose clamping machine consists of two hardened steel jaws, one of which is movable, and is operated by a compressed air cylinder, piston and rod. A tension spring is attached to the lower end of the movable jaw, providing for the opening of the jaws when the air pressure is released. An adjustable support is provided for the various sizes of hose used, and can be raised or lowered to suit larger and smaller hose sizes. After the coupling and nipple have been applied, the hose is then laid on the support and the clamp placed in position by hand. The operating valve handle is moved to application position, admitting air to the compressed air cylinder, forcing out the piston and rod and causing the jaws to close. This grips the clamp just back of the shoulder, closing in and holding it closed while the bolt is applied, and the nut run up on the bolt until it comes tightly in contact with the lug on the clamp. The pressure is then released by removing the operating valve to release position, the hose turned end for end and the same position repeated. The air pressure used in both mounting and clamping is 70 to 80 lbs.



AIR-OPERATED MACHINE FOR CLAMPING COUPLING HEADS AND NIPPLES ONTO AIR HOSE.

Locomotive Wheel Flange Lubrication

Lubrication is intended to reduce friction, and if one has a case where the friction is useless, it is only common sense to reduce it as far as may be. When we speak of a case of useless friction, we mean to draw a distinction between friction like that of a journal on a bearing, where useful work is being done and, of course, friction is simply retarding it, and other kinds, but we speak more particularly of what is called "rolling" friction, where a wheel on a rail is forced to give way before frictional resistance so that it turns round, and does not slip along the track. This rolling friction is resistance reduced to very low terms, but in a sense it is really useful.



FLANGE LUBRICATOR SHOWING CONSTRUCTION.

Going a step further, we come into the domain of higher mathematics. Take any point on the flange of a wheel, say the lowest point of a very sharp flange. If the wheel is 59 ins. in diameter, the point we are considering is 31 ins. from the centre of the axle. This point in a

LUBRICATOR IN PLACE ON WHEEL.

wheel with a very sharp flange scrapes and grinds on the side of the rail-head. Mathematicians tell us that in one revolution of the wheel·this point describes what they call a *curtate cycloidal* curve. It is because this flange-point is outside the circumference of the "generating circle," which in this case is the wheel itself. This "curtate cycloid" makes the form of a loop in rubbing against the rail-head, so that the kind of curve traced out by this lowest flange-point, while very interesting to mathematicians, is the worst form that could be found for actual railroad operation. Points at a less distance from the centre of the axle, yet still outside the tread, make smaller loops; that is, they grind and rub less than others situated at a greater distance, but wherever they are, they do their worst. They cause a certain loss of power, small or great, but it is there.

If the flange is new, and before these flange points touch the rail, they do no harm, but when they do touch, trouble begins. The flange keeps the wheel on the rail, whether new, or old and sharp, and this is what we mean when we directed attention to that which may be called "useless friction." We can do without it, or we can very materially reduce it, and yet not in any way interfere with the working of the machine. We cannot completely do that with journal and bearing friction. Flange friction is a detriment, pure and simple.

The Collins Metallic Packing Co. of Philadelphia have a way of meeting this flange friction difficulty by the use of their wheel flange lubricator. The lubrication is effected by the constant pressure against the wheel flange, of a stick made of a graphite composition. This stick approaches the wheel on an incline. In fact, the stick is housed in a tube of box- like shape, which fits the rectangular section of the lubricating stick. The stick is pushed against the wheel-flange, by the action of gravity intensified by a roller weight, which insures an equal pressure on the stick all the time.

The former plan was to get this pressure by the use of a spring, which, when new and strongly compressed, gave a tension of about 4 lbs. When the spring relaxed this tension was reduced to less than 1 lb. The stick of graphite first rubbed hard on the flange but gradually became almost non-effective as the spring relaxed. The present mode of feeding the graphite stick is to urge it down a neatly fitting tube by the action of gravity, supplemented by a roller weight, so that a constant pressure is always kept up on the stick, and it is fed to the flange steadily and with practically no variation of pressure and without fluctuation of any kind. This mode of procedure has the advantage of doing away with a spring, which may be lost, or stuck, and eventually becomes limp and slack. The lubricator is of convenient size, out of the way of other things, and can be set at any angle so that the feed may be adjusted to any rate that is desirable. Flange lubrication is important on account of its several economies.

The Collins lubricator is always "on the job," and there is little or no perceptible wear of the stick on the already lubricated flange. Generally speaking, and in ordinary cases, the lubricant lies on the flange like a streak of paint, and it is only when it is scraped off by flange contact with a frog or curved track that plentiful renewal is required. The lubricator is, then as always, in service to do the work, but lubrication is never wanting, and what we have called "useless friction" is practically made to disappear.

Ordinary Rules of Counterbalancing

By ROGER ATKINSON

The first operation is to weigh the reciprocating parts, piston and rod, crosshead and pin, and small end of connecting rod, add them together and call the total A. The weighing of the rod is done by placing it upon knife edges through crank and wrist pin holes, one of which supports rests upon a set of platform scales, and then reversing. The sum of the weights of the two ends should be the weight of the rod.

Second.—Weigh the revolving parts, that is, the side rods as distributed to each wheel, and to the weight of side rod on main wheel add the weight of the butt end of the connecting rod as above ascertained. The distributed weight of the side rod on each wheel is ascertained in the same manner as the connecting rod above; all the rods on one side should be coupled together, placed on knife edges through the crank pin holes, carefully levelled and the weighing machine inserted under each knife edge in turn. The sum of these weighings should be equal to the total weight of the rods.

Third.—Two-thirds of weight A should be divided into as many parts as there are driving wheels on one side and added to the weight of side rod found for each wheel, together with the by end of connecting rod on the main driver. We have then ascertained the weight to be balanced at the radius of the crank pin.

Fourth.—Place each pair of driving wheels successively upon a pair of trestles with journals resting on smooth flat strips of iron or steel and carefully levelled. Hang weights to one of the crank pins until it comes down to a horizontal position and if pushed gently in either direction will return to its position. If then the hanging weight is equal to the weight above ascertained the wheel is correctly balanced, if not, the balance weight in the wheel should be adjusted by increasing or decreasing accordingly. This should be done for each wheel.

Example: For a consolidation engine.

Recip'g W'ht.	Lbs.
Piston and rod....	525
Crosshead and pin.	232
Little end	239
	996 = A

Revolving W'ht.		Lbs.	¼ (A × ⅔) Lbs.	Total Reg'd. Lbs.
Side rod	L L	97	166	263
Side rod	L I	231	166	397
Side rod and butt end	L D	284 + 485 = 769	166	935
Side rod	L T	99	166	265

$996 \times \frac{2}{3} = 664$

$664 \div 4 = 166$ per wheel

Wheel.	W'ht Found, Lbs.	W'ht Reg'd, Lbs.	Shortage, Lbs.
L L	218	263	45
L I	181¼	397	215¾
L D	497¼	935	437¾
L T	207¾	265	57¼
Left	Total L. H.		756¼

Wheel.	W'ht Found, Lbs.	W'ht Reg'd. Lbs.	Shortage, Lbs.
R L	197¼	263	65¾
R I	146¾	397	250¼
R D	568¼	935	366¾
R T	198¼	265	66¾
Right	Total R. H.		749½

Trains of Naval Guns.

The city called Metz is pronounced as spelled "Mets" by the Huns, though the French pronounce it as if spelled "Maise." We will probably refer to it as "Mess," when General Pershing's large naval guns have been pounding at it for a few days with good, high-explosive shells and other missiles.

We said that naval guns were used, and it is true. Much has been written of the part the American navy is taking on the sea. Except for what the marines are doing, few know that the navy is also taking part in the fighting on land. The Navy Department has loaned several naval guns with expert crews to the army, and these gave efficient service in the recent offensive. Each gun requires a train of more than fifty cars to accommodate the crew, ammunition, and supplies.

Items of Personal Interest

Mr. A. C. Longdo has been appointed assistant fuel supervisor of the Minneapolis, St. Paul & Sault Ste. Marie.

Mr. R. E. Jones, has been appointed fuel and oil supervisor of the Duluth & Iron Range, and the Duluth, Missabe & Northern.

Mr. E. R. Manor, formerly chief electrician for the Northern Pacific, has been appointed assistant engineer of tests on the same road.

Mr. C. Gribbon has been appointed division master mechanic, London division, of the Canadian Pacific; succeeding Mr. A. Maynes, transferred.

Mr. Frank D. Shook, formerly car foreman of the Chicago, Milwaukee & St. Paul, has been appointed general car foreman at Spokane, Wash.

Mr. James D. Young has been appointed road foreman of engines on the Lehigh & Susquehanna division of the Central of New Jersey, with office at Ashley, Pa.

Mr. J. O. McArthur has been appointed roundhouse foreman of the Chicago, Milwaukee & St. Paul, at Aberdeen, succeeding Mr. W. D. Hayes, resigned.

Mr. C. G. Burnham federal manager of the Chicago, Burlington & Quincy, with headquarters at Chicago, has had his jurisdiction extended over the Paducah & Illinois.

Mr. Harry Modaff has been appointed division master mechanic of the Chicago, Burlington & Quincy, with office at Hannibal, Mo., succeeding Mr. O. E. Paradise, promoted.

Mr. W. C. Witts, formerly car foreman of the Chicago, Milwaukee & St. Paul, at Malden, Wash., has been appointed general car foreman at Harlowton, Mont.

Mr. R. J. Needham has been appointed mechanical and electrical engineer of motive power and car departments of the Grand Trunk with headquarters at Montreal, Que.

Mr. G. M. Wilson, formerly master mechanic at the Montreal locomotive shops of the Grand Trunk, has been appointed superintendent of motive power shops at Montreal.

Mr. A. Walter has been appointed division master mechanic of the Farnham division of the Canadian Pacific, with office at Farnham, Que., succeeding Mr. W. Wills, transferred.

Mr. R. J. Sporseller has been appointed road foreman of engines of the Pennsylvania, Western Lines, with office at Lancaster, Ohio, succeeding Mr. T. L. Todhunter, transferred.

Mr. S. W. Baker has been appointed manager of the extra work department of the Lima Locomotive Works, and Mr. M. K. Tate has been appointed manager of the service department.

Mr. G. F. McCormack has been appointed assistant division engineer of the Sacramento division of the Southern Pacific lines south of Ashland, with headquarters at Sacramento, Cal.

Mr. W. J. Barnes has been appointed engineer of power plants of the Baltimore & Ohio, Western lines; the Dayton & Union railroad, and the Dayton Union railroad, at Cincinnati, Ohio.

Mr. Paul C. Cheatham, sales representative of the Baldwin Locomotive Works and the Standard Steel Works at St. Louis, Mo., has been transferred to the Chicago office, succeeding Mr. A. S. Goble.

Mr. Clyde Medley, formerly assistant general car foreman of the Chicago, Milwaukee & St. Paul, at Miles City, Mont., has been appointed general car foreman, with headquarters at Seattle, Wash.

Mr. W. B. Mellon, formerly assistant foreman of the Pennsylvania at the twenty-eighth street shops, Pittsburgh, Pa., has been appointed engine house foreman of the same road at Youngstown, Pa.

Mr. F. E. Keenan, formerly trainmaster of the Southern Pacific, at Truckee, Cal., has been appointed district road foreman of engines, with office at Sacramento, Cal., succeeding Mr. W. L. Hack, promoted.

Mr. W. C. Weldon, purchasing agent of the Colorado & Southern, has had his jurisdiction extended to include the Denver & Salt Lake, with headquarters at Denver, Colo., succeeding Mr. A. L. Cochrane.

Mr. F. L. Carson, superintendent of motive power of the San Antonio & Aransas Pass, has been appointed assistant mechanical superintendent under federal control, with headquarters at Yoakum, Texas.

Mr. L. B. Wood, purchasing agent and storekeeper of the Southern Pacific, Texas lines, has been appointed general storekeeper of all lines under Mr. W. B. Scott, federal manager, with headquarters at Houston, Tex.

Mr. D. M. McLauchlan, formerly assistant master mechanic of the Southern Pacific, at Brooklyn, Ore., has been appointed master mechanic on the Portland division, succeeding Mr. G. E. Peck, resigned.

Mr. Robert F. Carr, president of the Dearborn Chemical Co., of Chicago, has been commissioned major on the general staff in the department of purchases, storage and traffic of the army, with headquarters at Washington, D. C.

Mr. F. D. Campbell, formerly general car foreman of the Chicago, Milwaukee & St. Paul, at Tacoma, Wash., has been appointed assistant master car builder of the lines west of Mobridge, S. D., with headquarters at Tacoma, Wash.

Mr. F. Ravena, formerly roundhouse foreman of the Erie at Cleveland, Ohio, has been appointed general foreman, and Mr. F. Svec, formerly fitting shop foreman, has been appointed erecting shop foreman, with office also at Cleveland.

Mr. J. A. Power, assistant general manager of the Southern Pacific, Texas Lines, has been appointed mechanical superintendent of all lines under the authority of Mr. W. B. Scott, federal manager, with headquarters at Houston, Texas.

Mr. J. A. McNulty, formerly railroad representative of the Anchor Packing Company, at Chicago, Ill., has been appointed division master mechanic of the Chicago, Milwaukee & St. Paul, at Dubuque, Iowa, succeeding Mr. G. T. Messer.

Mr. H. E. Dutton, purchasing agent of the Green Bay & Western, has been appointed purchasing agent also of the Kewanee, Green Bay & Western, the Ahnapee & Western and the Waupaca-Green Bay, with headquarters at Green Bay, Wis.

Mr. A. D. Williams, superintendent of motive power of the Southern district of the Southern Pacific, has had his jurisdiction extended over the Western Pacific, the Tidewater Southern and the Deep Creek railroads with headquarters at Sacramento, Cal.

Mr. F. W. Taylor, purchasing agent of the Southern Pacific at San Francisco, Cal., has been appointed purchasing agent of the Southern Pacific system, lines south of Ashland, Ore., the Western Pacific, the Tidewater Southern, and the Deep Creek.

Mr. I. F. Graham superintendent of motive power of the Oregon, Washington Railroad & Navigation Company, with headquarters at Portland, Ore., has had his jurisdiction extended over the Southern Pacific lines north of Ashland, and the Pacific coast railroad.

Mr. T. E. Paradise, division master mechanic and trainmaster on the Chicago, Burlington & Quincy, with headquarters at Centerville, Iowa, has been appointed mechanical assistant to the regional director of the Central Western region, with headquarters at Chicago, Ill.

Mr. C. L. Fuller, formerly assistant

general foreman at the Milwaukee shops of the Chicago, Milwaukee & St. Paul, has been appointed general foreman. Mr. Wm. G. Corbett succeeds Mr. Fuller, and Mr. T. J. Huepper has been appointed machine foreman, succeeding Mr. Corbett.

Mr. I. N. Clark has been appointed master car builder on the Ontario lines of the Grand Trunk, with headquarters at London, Ont., and Mr. I. Brooks has been appointed assistant master car builder at the London shops, and Mr. W. A. Pitt has been appointed assistant master car builder at the Montreal shops.

Mr. W. A. Callison has been appointed superintendent of motive power and Mr. L. B. Morehead mechanical engineer of the company formed by the consolidation of the Chicago, Indianapolis & Louisville, and the Cincinnati, Indianapolis & Western, both with headquarters at Lafayette, Ind.

Mr. W. T. Hendrix has been appointed roundhouse foreman of the Chicago, Milwaukee & St. Paul at Avery, Idaho, succeeding Mr. J. A. Wright, promoted; and Mr. Earl Walters has been appointed machine shop foreman on the same road, with office at Deer Lodge, Mont., succeeding Mr. D. J. Davies, resigned.

Mr. C. M. Kittle, federal manager of the Illinois Central, the Yazoo & Mississippi Valley, the Gulf & Ship Island, the Mississippi Central, the New Orleans Great Northern, the St. Charles Air Line and the Helena Terminal, Helena, Ark., has had his jurisdiction extended also over the Chicago, Memphis & Gulf, with office at Chicago, Ill.

Mr. C. E. Haygood, manager of the railway department of the Manila Electric Railroad and Light Company of Manila, Philippine Islands, is visiting the United States on a vacation and for the purpose of consulting with the officers of the J. G. White Management Corporation, New York, N. Y., the operating managers of the Manila Company. He expects to return to the Philippines some time before the first of the year.

Mr. J. H. Rodger has been elected vice-president of the Safety Car Heating & Lighting Company, with office at Chicago, Ill. Mr. Rodger has been associated with the company since 1911, prior to which he was with the Standard Coupler Company. Mr. Rodger succeeds Mr. A. Clark Moore, who has been commissioned as major in charge of aircraft production in the New York district.

Mr. A. Clement A. Hardy, formerly sales engineer and mechanical engineer for the Whiting Foundry Equipment Company, has disposed of his interest in that company, and has opened an office in the Railway Exchange Building, Chicago, Ill., as consulting and contracting engineer, and is making preparations to meet the growing demand for his locomotive jack, which is already in operation on about twenty of the leading railroads.

Mr. W. C. Curd, former Drainage engineer of the Union Pacific, in charge of water service on that road, and who is one of the best experts in water service matters, has recently joined the railroad department of the Wm. Graver Tank Works, Chicago, Ill. During the last few years Mr. Curd has been employed by a number of the leading trunk lines, as expert in law suits which they have had in Cincinnati with water service conditions upon their lines.

Col. Horace C. Booz has received his honorable discharge from the United States Army, and has entered upon his duties as Corporate Engineer of the Pennsylvania. Col. Booz was formerly assistant chief engineer of the Pennsylvania, and after vice-president W. W. Atterbury went to France, in the summer of 1917, as Director General of Transportation of the American Expeditionary Forces, with the rank of Brigadier General, he asked that Mr. Booz be sent over to become one of the principal members of his staff, and indefinite leave of absence was granted to him, and he was appointed Engineer of Construction in charge of building port and railroad facilities for the American forces in France. The Railroad corporation was left without an engineering representative, hence, an urgent request was made by the government for the return of Col. Booz for the purpose of inspection and approval of plans, estimates and improvements and extensions for which no other man was so eminently qualified. He was a student at Lafayette College from

COL. H. C. BOOZ.

which he graduated as civil engineer in 1895, and entered the engineering department of the Pennsylvania in the same year. He was appointed assistant chief engineer of the company in 1911.

Obituary

Robert M. Dixon.

Robert Munn Dixon, president of the Safety Car Heating and Lighting Company of New York, was born on September 19, 1860, at East Orange, N. J. He died on October 16, 1918. Mr. Dixon was elected vice-president of The Safety Car Heating and Lighting Company on January 15, 1902, and was made president of the company in May, 1907, which office he held at the time of death. The greater part of his life was spent in the field of railway car heating and lighting. He was identified with the first application of steam from the locomotive for heating railway passenger cars and with the development of gas and electricity for lighting railway cars, and he was also active in the field of harbor and coast lighting.

ROBERT M. DIXON.

He was a member of the American Society of Mechanical Engineers for 35 years. He was president of the Alumni Association of Stevens Institute of Technology 1898-1899, and an alumni trustee 1890-1893. It is with feeling of the greatest regret and sorrow that the news of his death came to his many friends and acquaintances. Mr. Dixon will be greatly missed among the members of the leading railroad clubs and societies among whom he was long a moving spirit.

Hiram W. Belnap.

Hiram W. Belnap, manager of the safety section of the division of operation, United States Railroad Administration, died at his home in Washington, D. C., on October 12, 1918. Mr. Belnap was stricken with Spanish influenza, which culminated, after a few days' illness, in pneumonia. Mr. Belnap was in his 52nd year, and had been connected with the

Interstate Commerce Commission for 15 years, previous to which he had been in railroad service in the operating department. Since last July he had been actively engaged in organizing the safety departments of the railroads with a view to a similarity in organization and methods. His work in the service of the Government was very much appreciated.

John J. Smart.

John J. Smart, one of the founders of the W. J. Crouch Company Inc., and since its amalgamation with Rownson, Drew & Clydesdale, Inc., manager of the Manufacturing Division, died suddenly on Sunday, October 20, after a brief illness, due to the prevailing epidemic. Mr. Smart was a man in the prime of life. His death was unexpected, and is a severe shock to his associates. He did much toward the success which the W. J. Crouch Company attained, and greater things were expected of him under the new arrangement, by which he became manager of the Manufacturing Division of Rownson, Drew & Clydesdale, Inc. His death will leave a gap that cannot easily be filled.

There was in his case a subtle characteristic quality which easily endeared him to all who came in contact with him. This quality is often called "personality," and the possessor of this method of easy and friendly approach is a business attribute of the highest possible value. Mr. Smart had it in a marked degree and his company and his many friends will mourn his loss with sincerity and with an enduring memory.

Waste of Fuel Oil.

The experts of the Bureau of Mines, Department of the Interior, have been co-operating with the Fuel Administration in a general survey of the use of fuel oil for power purposes in the United States. They find that last year 160,000,000 barrels of fuel oil were used and that 40,000,000 barrels, or one-fourth of the entire amount, was wasted and might have been saved by more intelligent operation of plants and proper firing. This represents a useless expenditure of $140,000,000 a year, or enough money to pay some of the country's important war bills, the fuel oil selling at about $3.50 a barrel. The experts also say that this wastage is doubly criminal at this time because of the urgent need of fuel oil for the ships of the Navy and for other essential war purposes. Further they declare that the 40,000,000 barrels of fuel oil lost each year is the equivalent of 10,000,000 tons of coal.

With such a situation confronting the country, both the Bureau of Mines and the Fuel Administration have sent into those parts of the country where fuel oil is extensively used a number of engineers who have been visiting the plants and endeavoring to demonstrate to the men where losses occur and showing how they may be stopped. As one result of the investigation a handbook for boiler-plant and locomotive engineers in the efficient use of oil fuel has been issued by the Bureau of Mines giving instruction to all those who have oil burning plants. Van H. Manning, Director of the Bureau of Mines, has ordered that a copy of these instructions be forwarded to all known plants using fuel oil. Railways can also get them.

Hudson Bay Railway.

The route of the Hudson Bay Railway lies between Le Pas, Manitoba, where connection is made with the Canadian Northern Railway, and Port Nelson of Hudson Bay, a total distance of 424 miles. The work of construction was placed under contract in August, 1911. The entire line has now been graded and track laid from Le Pas north to the second crossing of the Nelson River at Kettle Rapids, a distance of 334 miles, to which point also telegraphic communication has been established. All bridges up to and including that at Kettle Rapids, have been completed. Between this point and Port Nelson two bridges have yet to be constructed. Considerable progress has been made on railway terminals, docks and other harbor works at Port Nelson.

Waste of Power at Niagara.

Some engineering authorities claim that five million horse-power is being wasted by omitting to utilise fully the Niagara Falls. The annual value of the power going to waste is at least $50,000,000; and, meantime, important works are suffering from lack of power to operate at the full capacity for which they were designed. It is stated that industrial men on both sides of the Falls are anxious for more complete utilization, and that the only obstacle is Governmental inertia. The proposed consolidation of the Niagara Falls Power Company, the Hydraulic Power Company, and the Cliff Electrical Distributing Company would be followed by expenditure of $15,000,000 on new equipment, and a total increase in output of 170,000 H. P.

Annealing Steel

According to a recent patent by F. Bagliardi, of Milan, Italy, high-speed steel is annealed by heating it to 500-550 deg. C., withdrawing it from the fire, allowing it to cool for a few seconds beneath cinders, and then immediately quenching it in water or grease, or preferably in a mixture of 200 parts of animal grease not containing stearin, 700 parts of tallow, and 100 parts of charcoal.

Railroad Equipment Notes

The Biddle Purchasing Company, Chicago, is inquiring for 100 standard-gauge, four-wheel trucks.

The Grand Trunk is taking bids on a coaling plant at Portland, Me., which will require 1,200 tons of steel.

The Atchison, Topeka & Santa Fe will build a new electric power plant at Shopton, Iowa, to cost about $75,000.

The Great Northern has ordered 675 tons of steel for deck and through girder spans from the Milwaukee Bridge Company.

The War Industries Board is expected to place orders shortly for approximately 5,000 four-wheeled gondola cars for the Italian Government.

The Boston & Maine has let a contract for erection of an engine house, a boiler house and an office building at Rotterdam Junction, N. Y., to cost $75,000.

New York, New Haven & Hartford has filed plans for a one-story brick addition, 43 by 200 ft. to its engine house at East 132nd street, New York.

The New York Central has awarded contract to the Robert W. Smith Corporation, New York, for erecting car repair shops at Belle Isle, N. Y., to cost $60,000.

A coaling plant valued at $30,000 will be erected at Ogdensburg, N. Y., by the New York Central. The same road is taking bids for an addition to its shops at Avis, Pa.

The American Locomotive Company, it was announced at the annual stockholders' meeting October 15, has closed a contract with the Italian Government for 150 locomotives.

The Pennsylvania Lines West are reported buying a large number of machine tools for new shops and roundhouses at Columbus and West Akron, Ohio, and Logansport, Ind.

Locomotive builders delivered a total of 64 locomotives during the week ended October 5: American Locomotive Company, 40; Lima Locomotive Works, 9; Baldwin Locomotive Works, 15.

The Rutland Railroad has let the contract for a 50-foot high, 105 by 263-foot locomotive shop, 125 by 172-foot coach repair shop, two 75 by 186-foot and 45 by 209-foot transfer tables and a brick, two-story 35 by 50-foot office building at Rutland, Vt.

The Pennsylvania Railroad has awarded the general contract to Braun & Stuart for a $100,000 extension to its engine house No. 2, Philadelphia, Pa., and the general contract for a $100,000 extension to engine house No. 4 to the Wm. Steele & Son Co.

The Government's inquiry for cars for the American Expeditionary Forces in France calls for 40,315 cars, classified as follows: 4,060 flat cars, 9,670 low-side gondolas, 7,135 high-side gondolas, 7,840 gondolas with cabs, 10,010 box cars, 550 refrigerator cars and 1,050 tank cars.

The Philadelphia & Reading has filed plans for two reinforced concrete buildings at its shops, Tulip and Somerset streets, Philadelphia, Pa., consisting of a one-story structure, 42 by 50 feet, with wing 37 by 43 feet, to cost $36,000, and a one-story building, 17 by 37 feet, to cost $10,000.

The Baltimore & Ohio has awarded a contract to Franie Brothers & Haigley, Baltimore, Md., for the construction of a one-story machine shop at Putnam and Paca streets, in that city, 120 by 200 ft., to cost $10,000. It is also planning for the construction of a new engine house with shop facilities at Clarksburg, W. Va.

The Chesapeake & Ohio has awarded a contract to the Roberts & Schaefer Company of Chicago for the building of a 500-ton capacity reinforced concrete, automatic, electric locomotive coaling plant, using the Duplex shallow pit feeder, for installation at Concord, Ky. A similar plant for this road is now being constructed by the Roberts & Schaefer Company at Handley, W. Va.

The Pennsylvania has completed plans for its new shops and engine house at Marietta, Pa., to cost $500,000. Contract has also been awarded to T. L. Eyre, Philadelphia, for a one-story engine house with locomotive repair facilities, at the Gray's Ferry avenue yards, to cost $60,000. The company has also awarded a contract to Rodyhouse, Arey & Co., Philadelphia, for an engine house and shop facilities at Emporium Junction, Pa., to cost $100,000.

The Philadelphia & Reading has awarded a contract to A. L. Carhart, Philadelphia, for its new engine house, shops, etc., at Rutherford, Pa., consisting of a one-story building, 114x132 feet, to cost $100,000. Contract has also been let to the F. A. Havens Co., Philadelphia, for an addition to the engine house and turntable installation at St. Clair, Pa., to cost $41,000.

Books, Bulletins, Catalogues, Etc.

Power Punching and Shearing Machinery.

The Long & Allstatter Company, Hamilton, Ohio, have issued Catalog No. 21-A, describing and illustrating punching and shearing machinery. There are over 300 pages and an almost equal number of illustrations, all in the highest style of the illustrators' and printers' art. In addition to the great variety of punching and shearing machines there are a variety of new forms of riveting machines. Tables of circumferences and areas, weights of flat and round steel, wire gauges, and other data form a valuable appendix to the publication, which reflects more than half a century of experience in the manufacture of special lines of machinery, ranging from the very smallest to the very largest and most powerful types.

Saving Coal in Boiler Plants.

The Bureau of Mines is doing a notable work in disseminating information concerning the economic use of coal. The 24 page pamphlet on the Saving Coal in Boiler plants, by Henry Kreisinger, contains a mass of matter in regard to what can be done in saving coal. According to the data furnished there is need of saving. It appears that among other losses out of every 100 tons of coal burned under the boilers, the heat of 35 tons literally goes up the stack. It is this loss that can be greatly reduced and every effort should be made to do so. Special comments are made on the best methods of firing, and obtaining records. Every effort should be made to get such records by measuring the water fed into the boilers or the steam passing out through the steam header. A certain number of pounds of water evaporated for each pound of coal fired could be adopted for a standard, and every time higher evaporation than the standard is obtained the fireman and the engineer could receive a reward proportionate to the increase of evaporation. Copies of the pamphlet may be had free on application to the Superintendent of Documents, Government Printing office, Washington, D. C.

The Tool-om-eter.

The New Jersey Meter Company, Plainfield, N. J., has issued an illustrated descriptive circular explaining the principle of the company's improved type of compressed air meter. The "tool-ometer" takes its name from its chief application, the measurement of air used by pneumatic tools. It will detect and measure leakage in air lines, valves, hose, cocks, and other appliances; determine the net volume of actual air produced by compressors for comparison with nominal rating or displacement, shows where the air goes after it is compressed, and furnish the facts on various disputed questions. It is especially serviceable in testing small tools, chipping and riveting hammers, plug, hammer and air feed drills, wood boring and metal drilling mahcines, hoists and motors. The appliance has a capacity of 10 to 100 cubic feet of free air per minute, and has the reliability of a standardized instrument.

Rigidity of Riveted Joints.

The experiment station of the University of Illinois has issued Bulletin No. 104, description of "Tests to Determine the Rigidity of Riveted Joints of Steel Structures." The tests were conducted under the direction of Wilbur M. Wilson, Assistant Professor of Civil Engineering, and Herbert F. Moore, Research Professor of Engineering Materials. The pieces tested were connections which are types common in engineering structures and which resist loads and moments fundamentally different. The result of the tests are given in detail, and copies of the Bulletin may be obtained without charge, by addressing the Engineering Experiment Station, Urbana, Ill.

The Commonwealther.

The Commonwealth Steel Company's organ published every little while in the interest of fellowship grows more interesting with each issue. Intensely patriotic, it breathes a spirit of courageous earnestness in the great cause in which the embattled Allies are engaged. It keeps in touch with the 484 Commonwealth men in the service, and doubtless cheers the heroic spirit of the brave men fighting for the right, but in a larger sense all the Commonwealthers are in the service, because Uncle Sam's requirements supersede all else. The 16 bright pages reflect the kindly spirit, the cheerful activity, the warm fellowship, the high endeavor blossoming into artistic skill, the record of work well done, the merging of employer and employee into one common group of workers in the same field.

Hunt-Spiller Iron.

The Hunt-Spiller Manufacturing Corporation has issued a booklet setting forth the reasons "Why Railroads Use Hunt-Spiller Gun Iron." Those who have had the opportunity of observing the excellent qualities of the metal in use on the modern locomotive do not require the reasons to be urged. Those who have not had such opportunities should send for a copy of the booklet to the company's office, South Boston, Mass.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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The Work of the Allies' Railroad Army In France. Fidelity of the Belgian Railroad Men

The degree of perfection in transportation of the men and munitions needed in the Allies' campaign against the German invasion of Belgium and France has been particularly marked since the addition of 60,000 Americans operating over 1,000 locomotives and 5,000 freight cars over 6,000 miles of railway tracks. Little over a year ago these men were at work on American railroads, and when they became soldiers they needed no period of training. They had already learned in the unwritten but stern code of practical railroading and about orders. They had been used to making out orders and acting on them without lengthened experiments.

To work efficiently the transportation department had to enlarge many existing French lines and terminals, lay heavier rails, and establish new and larger shops. An American company also built a large plant in France, where it has constructed freight cars for the French Government at actual cost, the entire metal portions of the cars having been transported from America. Two freight yards established by the American engineers in France have nearly 700 miles of sidings, one with over 400 miles and another having 257 miles.

ALLIED ENGINEER REGIMENT LAYING RAILS BEHIND THE BATTLE LINE IN FRANCE.

The American engineer officers state that they found the physical condition of the French railways that they took over to be remarkably good considering the hard service they had been called upon to undergo. More than 1,000 miles of new track had to be laid to connect up existing French lines which had to be changed to suit the use of the larger locomotives hauling thirty-ton cars instead of the ten-ton cars formerly in use. The use of many of the modern appliances and improvements in methods in American railroad practice was a matter of wonder to French railroad men of the old school. Special water tanks had to be constructed for the big locomotives, and on some of the principal lines scoop water-troughs between the lines were built. Trains of unheard of length in Europe were in constant motion, and it may be relied on that the object lessons furnished by the American engineers to the French railway men will not be forgotten.

The British engineers have also done excellent work on the French railroads. Their equipment is, of course, of the lighter type, as compared with American practice, but in the matter of adaptability our illustration showing a rail-mounted

big gun is a proof that the British have shown a mastery in the transportation and use of artillery that has not been surpassed in the annals of the great war.

We had described, in the early days of the war, and also illustrated smaller types of locomotives used on the narrow gauge railroads, a large number of which were constructed in America, the most popular in the first year of the war being what is known as the Pechot type. They are almost similar to what are known as the Fairlie type of locomotive, consisting of a two-barrelled boiler and two fireboxes, with a cab in the center and water tanks on the sides of each of the double-ended engine. The locomotive is carried on two swivel trucks. The gauge is less than 2 ft. Such a locomotive is exceedingly flexible, and where curves are sharp and rails resting on little other than the common earth, an amount of traffic has been carried on by the use of these locomotives that could not have been accomplished in any other way. They may be said to be an outgrowth of the necessities of the war, and will in all likelihood pass into disuse with other war material that has served its purpose.

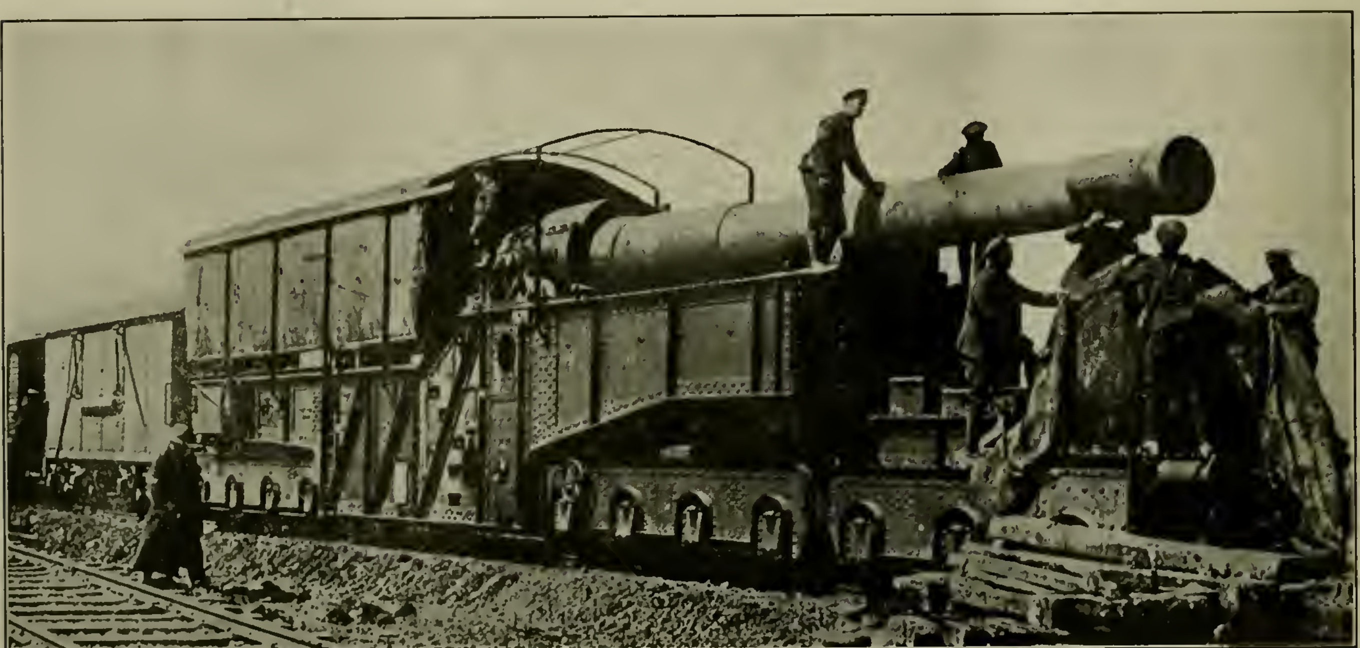
It might be added in this connection that the railway men of Belgium have shown a spirit whereby they may be said to have become ennobled. After the failure of the Germans to break through to Paris or Calais and their defeat at the Marne, on the Yser and before Ypres, the Germans began to organize for a long war and to draw all fit men into essential services. As many Germans as are required for an army corps were employed on the Belgian railways and, in order to free them for military service, the occupying government tried to persuade the Belgian railwaymen to return to work, pointing out to them that the railways were still of service to the civil population when not required by the military. The Germans offered an all round increase of wages and specially high rates to drivers (at Liege $10 per day was offered to drivers accustomed to the inclined plane of Haut Pre). All the railwaymen refused these offers and resisted with the same courage when the Germans tried force instead of persuasion.

The Germans then secured the names of the men, arrested them singly in their homes and escorted 500 of them to the works, where, on their refusal to work they were incarcerated. Finding the men stubborn the Germans penalized the town. No one was allowed to enter or leave it and the population had all to be indoors by 6:30 p. m. Still the men would not give way and eventually the Germans were obliged to raise the embargo, without having achieved their object.

As regards railwaymen, the Germans were really more anxious to use their services in Belgium than in Germany and instances of pressure brought to bear on them and which amounted to a regular persecution, are too numerous to mention. At Tournai the railwaymen were condemned to four months' imprisonment for refusing to work on German engines. Finding them equally obdurate at the end of the sentence it was increased to a year's imprisonment, during which time they were nearly dying of hunger.

In February, 1918, at Mouscren, a small town in West Flanders, two guards and a railway laborer were sentenced by a military court for "acts opposed to German interests." One of the guards was condemned to death and immediately executed; the two others were sentenced to 15 years' hard labor. In order to terrorize the population the town was placarded with their names and punishments. We may be grateful thus far to Germany for giving us their names to honor, Achille Debacker executed, Henri Debavoy and Jules Leuridan imprisoned.

These facts are well authenticated and could be largely added to, and are part of a report of the official commission on the violation of the Rights of Nations.



BIG GUN MOUNTED ON A RAILWAY TRUCK FIGHTING WITH THE ALLIES IN FRANCE.

Spark Arresters and Ashpans.

The Railroad Administration's mechanical department circular No. 5 provides that a careful and thorough inspection of every part of the spark-arresting appliances in the front end of locomotives must be made every time that the front door is opened, and these intervals must not exceed seven days. The ashpans, hoppers, slides or other apparatus for dumping cinders, must also be inspected. In extreme drought or if the state of adjoining property, or crops require it, inspection must be made every 24 hours. A record of condition must be made and signed by those making the inspection. Nettings and spark arresters must be in serviceable condition before the locomotive is put in service. Defective netting and plates should be renewed instead of being patched. Ash pans and hoppers must be tight, and dampers, slides or apparatus for dumping cinders must be in good working order, closing tight. Record of all repairs must be made, with the date, and entries to be made and signed by the person doing the work. The order is now in effect.

Heavy U. S. Standard 2-8-2 Locomotives for the Chicago, Milwaukee & St. Paul Railway

The design of the heavy Mikado, or 2-8-2 locomotives, is on the lines of the lighter type of the same class. The American Locomotive Co. have recently turned out a number of the heavy class and these have been assigned by the U. S. Government to the Chicago, Milwaukee & St. Paul Railway. As far as possible, interchangeability of parts has been arranged for, between these C., M. & St. P. engines and the lighter standard of the same class, designed by the U. S. Railroad Administration, which is also the originator of the design under consideration.

The boilers are of the conical wagon-top type, having a diameter at the front course of 86 ins. increasing up to 96 ins. at the dome course. A comparison of these, and the light Mikado class, reveals the fact that the tube sheet is 3 ins. further back from the centre of the cylinder saddle, than it is in the light Mikados, and the combustion chamber of the C., M. & St. P. engines is 21 ins. deep instead of 24 ins. of the lighter machines. The tubes are 19 ft. 0 ins. long. There are 247 tubes, each 2¼ ins. diameter, and as the engine is equipped with a type "A" superheater, there are 45 flues of 5½ ins. diameter. The boiler has four Cole safety valves of 3 ins. diameter each, and it is also supplied with a Chambers throttle valve.

The firebox is 6 ins. longer than the light Mikados, and measures 120⅛ x 84¼ ins. This gives a grate area of 70.8 sq. ft. The lighter engines of this class, we may mention, have a grate area of 66.7 sq. ft. This C., M. & St. P. engine has a Security brick arch, and a Shoemaker style of fire door. It has also a Franklin grate shaker, and is fed with fuel by a Standard automatic stoker. The ashpan is made with two hoppers, opening with swinging doors, placed in front of the trailing axle.

The frame construction very closely resembles that of the light Mikados previously built. The main frames are made of cast steel, and are 6 ins. wide, and include integral front frame rails. Over the pedestals, the top rail has been strengthened by making it 6¾ ins. The lighter section between the pedestals measures 5¾ ins. in depth. These parts are slightly heavier than those of the light Mikado class. Over the binders the lower rails and the frames have a depth of 4⅛ ins. Under the cylinders the frames are of slab section 6 ins. wide, and 10¼ ins. deep. At the very front where the front deck casting rests, the frame is 10 x 3½ ins. section.

The wheel spacing of these engines is like that of the light Mikado engines, and it is also similar in the distance between the centre of the cylinder saddle and the front pair of driving wheels, and that between the rear driving wheels and the trailing, or as they are sometimes called, the carrying wheels. This latter figure is 10 ft. The trailer frames are two separate steel castings, each of which is fastened to one of the main frames, by fourteen 1¾ ins. bolts. The back ends of the trailer frames are bolted to the rear deck casting. The frame bracing consists of vertical cross-ties bolted to the front legs of the front driving wheel pedestals and bolted to the back pedestals of the second and third pairs of driving wheels. There are also deck braces fastened to the top frame rails between the first and second, and between the third and fourth pairs of driving wheels. The front vertical brace has a diagonal extension which is bolted to the lower frame rails, back of the cylinders, and in which is also included the radius bar pivot for the front engine truck and the driver brake fulcrum.

Except the main driving boxes, which for journals are 12 ins. in diameter and 13 ins. long, all others fit the lighter Mikados. These other journals are 10 ins. in diameter and 13 ins. long. The driving wheels have brass hub liners. The engine springs for these C., M. & St. P. engines are heavier than those of the lighter engines. The Economy constant resistance engine trucks are used on the heavy and light type engines. This heavy Mikado type of engine is supplied with the Cole-Scoville style of trailer trucks.

Gun-iron is used to make bushings for the cylinders and valve chambers. The steel pistons are of single plate section, with gun-iron wearing shoes.

The valve motion is the Walschaerts, and is fitted with the Lewis power reversing gear. Paxton-Mitchell packing is used on the piston rods and valve stems. The details of the valve motion are similar to those used by the light Mikado type of locomotive, the same design of piston valve and link are used on both classes, and the valve chamber heads are interchangeable.

HEAVY U. S. STANDARD 2-8-2, ALLOTTED TO THE CHICAGO, MILWAUKEE & ST. PAUL.

R. H. Warnock, G. S. M. P. American Loco. Co., Builders.

The standard 10,000-gals. tender used here is similar in design and make, to that used with the lighter Mikados. This form of tender will probably be employed with other engines. The tender is carried on two, four-wheel trucks, the axles having 6 x 11 ins. journals. The brake beams are carried on the Creco three-point support, and Woods side bearings are used.

The main rods are made so that the section shows a heavy body with deep channels, and the stub ends are formed with straps, so that the crankpin brasses are removable. The locomotive is fitted with Everlasting blow-off valves, Ashcroft gauges, Detroit lubricators (six feed), No. 11 Hancock injectors (non-lifting), Barco flexible connections between engine and tender, Barco blower fitting, Sargent blower valves (quick acting), Radial buffers and the Unit safety bar between engine and tender.

Some of the principal dimensions and ratios are as follows: Standard gauge of track; cylinders 27 x 32 ins.; Diameter

of driving wheels, 63 ins.; steam pressure, 190 lbs.; fuel, bituminous coal; wheel base of the drivers is 16 ft. 9 ins.; that of the engine is 36 ft. 1 in., and of the engine and tender together, 71 ft. 8½ ins. The weights on the various wheels are: on the engine truck 24,000 lbs., on the driving wheels 239,000 lbs., on the trailing or carrying wheels 57,000 lbs., making the total for the whole engine 320,000 lbs.. and with the weight of the tender, which is 183,800 lbs., the weight of the whole thing comes to 503,800 lbs. This engine with wheels, cylinders, steam pressure as given, is able to develop a calculated tractive effort of 60,000 lbs., and the factor of adhesion is 3.98.

The engine is simple, with 14 ins. piston valves. The greatest valve travel is 7 ins., outside lap 1⅛ ins., lead in full gear 3-16 ins., no inside clearance. The diameter of the engine truck wheels is 33 ins., that of the trailer truck wheels is 43 ins. The engine truck journals are 6½ x 12 ins., trailer axle journals 9 x 14 ins. The boiler, as we have already said, is of conical wagon-top shape. The tube sheet is ½ in. thick, the side, back and crown sheets are each ⅝ ins. thick. The firebox water spaces are sides and back each 5 ins., and the front is 6 ins. The heating surface of tubes and flues is 3,978 sq. ft., the firebox with arch tubes counted in, comes to 319 sq. ft. These added together give a total of 4,297 sq. ft. The superheater heating surface is 993 sq. ft. If this was added as it stands, it would make the total heating surface 5,290 sq. ft., but upon the basis (which some calculators use, though not universally accepted), the total heating surface is given as equivalent to 5,787 sq. ft. This last figure is got purely on the assumption that what is called "equivalent heating surface," it is the total heating surface, with 1½ times the superheater heating surface added.

The tender has a water bottom, and the frame is made of cast steel and the tank holds 10,000 U. S. gallons of water and carries 16 tons of coal. This engine shows some interesting ratios; for example, the weight on the driving wheels, when divided by the tractive effort, gives 4, which is a normal figure. The total weight when divided by the tractive effort gives 5.4; the tractive effort figure multiplied by the diameter of the driving wheels, and the product divided by what is called the equivalent heating surface, gives 653.2; the equivalent heating surface divided by the grate area gives 81.7; and the firebox heating surface divided by the equivalent heating surface, and the percentage taken, gives 5.5. The whole machine has a good appearance.

A Theory of the Fatigue of Metals

A good deal of research work in the investigation of metals under stress has been done at the U. S. Bureau of Standards, Washington, D. C., by Mr. F. J. Schlink, an associate physicist, and an article on the subject of metal fatigue has lately appeared in the *Engineering News-Record*. In it the gradual approach of failure has been typified by the behavior of a piece of cloth which was made to undergo a strain, and was subsequently released, and again and again stressed, with an interval between each recurrence. The author says: "When a tensile load is applied to this material it is certain that before all of the longitudinal yarns can take up the stress, a phase of mutual adjustment of the yarns and their component fibres must take place. Some will be slack, while others will be taut, some will be in close adherence to their neighbors while others will have comparative independence of action in the initial unstressed condition. When the load is applied the slack fibres and yarns take up a portion of the load, after the first stretching of those that are taut, while those which adhere to adjacent ones will slip relatively to their neighbors.

If, before the last named state is reached, the load is removed, the specimen will return to a condition of zero stress, but its extension will not return to zero, as some of the displacements which have taken place during the earlier stages of stress application are not reversible, being maintained at more or less definite values by the friction which exists between the continguous elements. If a second cycle of loading take place, many of these adjustments will not recur, since the fibres have been permanently disposed into positions more favorable to uniform distribution of the stress. A fairly definite proportion of them, however, will recur, comprising mainly those which, due to insufficiency of friction between elements, have been allowed to appropriate their initial condition of slackness or mutual contact. Thus at every repetition of the loading and unloading cycle certain slips and shifts will take place in the fabric, decreasing, however, in number and extent with each succeeding repetition.

"It is this condition which must largely account for the ultimate failure of the fabric under repeated loadings since the energy involved in these slips and shifts of the fibres and yarns is largely expended in mechanical wear of the material itself, diminishing the effective cross-sections and breaking down the adhesions and interlockings which exist between the component yarns of the fabric."

It appears from this that it is almost impossible to apply a strain so that all the fibres will be uniformly taxed at once and all from the start, but that some limited number will take the initial strain, and stretch, others quickly following, will slip on adjacent fibres, and finally a sufficient number of them will be able to take the full load, and when unloaded will be able to go partially back to, or go back nearly to their former positions. In all this there is a slight, perhaps imperceptible, deformation which never wholly disappears.

The effect of the load produces a slight ineffacable stretch in the fibres which first feel the load, and the slipping, one may even say, disentangling, of the second lot of fibres, is a form of work which the applied load performs, and this "work" causes a very slight wear and stretch of the parts, so that if the process is kept up long enough, ultimate failure is brought about, like the slow filing away of substance when even the lubricated surfaces of crosshead and guides rub upon each other for a long period of time, and this produces the "loose guides," with which we are all so familiar.

Some railways, perhaps without any very well defined reason, set a time limit to the endurance of their car axles, and do not take account of the mileage made per car. It is assumed, perhaps rightly by them, that the average time of service is practically accurate enough to be applied to all cars, and they are in reality allowing for this very form of loading and unloading of the axle, which is slowly yet imperceptibly disintegrating the internal structure of the metal. Good quality of material seems to be, from what we have been considering, nothing more than the ability of a piece of metal to put quite a large number of fibres into the field, to take up the initial strain and to lock other fibres together, so that they will not readily slip or disentangle. By so doing, this good quality metal, longer withstands the disintegrating and fibre-wearing "work" of the intermittantly applied outside strain.

Metal stands to fail, from the moment it is put in service, and to give up its use despite appearances seems to be the course dictated by reason. The failure of metal, by what is called "fatigue" is, if our author's reasoning means anything, the culmination of a long, drawn-out process, and does not come to us like a bolt out of the blue.

Train Resistance and Draw-Bar Pull

Speaking in general terms there is a relation of train resistance to speed, and there are elements that go to make up the resistance to the movement of a car on a level track. These are journal resistance; air resistance, including wind; and miscellaneous things, such as flange friction, rolling friction, and any shocks or concussions that may arise on account of slight defects in the track.

Journal resistance is reduced to an almost negligible quantity by careful fitting of the journal and brass and by proper and effective lubrication. Air and wind resistance are variable and can be recorded and allowed for, by the observer, but not controlled by anything he is able to do. Air and wind resistance, however, increase with speed.

In 1907 some tests were made on the P. R. R. to find out the resistance offered by a twenty-ton car on a level tangent. The resistance was found to amount to 8 lbs. per ton. Since that time other experiments have shown that 7 lbs. per ton was nearer the mark. In some of the tests a stop of from 10 to 30 minutes was made for experimental purposes, and some of the runs showed an increased resistance after the start. On a level tangent a car weighing 72 tons with the load included in this figure, moving at slow speeds showed a resistance of from 2½ to 4 lbs. per ton. On good tangent track 3 lbs. per ton for a 70-ton car (gross weight), is a fairly accurate average. Cars of less gross weight were found to pull heavier or with more resistance. A probable explanation of this is that the same number of wheels and axles in heavy and light cars, produce very different results. The concentrated load carried on comparatively few wheels gives less resistance than the lighter car riding on the same number of wheels, and the rolling journal, and flange friction does not rise in the same ratio as the gross car load.

In the tests, which also included experiments on a given grade, the figures so found were "corrected" for level track, so that they are not specifically shown in the results given below, but they have been recorded and their effect has been introduced into the calculations and the whole appears as a level track resistance with the grade referred to, having been taken into account. It is difficult, if not impossible to get a tangent long enough and without any grades, to give the desired results at first hand and without a "correction" for what the result must be as if taken under practically perfect and unattainable conditions.

A table prepared for the level tangent resistance of freight cars shows approximately 80 tons gross gives 2¾ lbs. per ton; 70 tons 3 lbs. per ton; 60 tons 3.27 lbs., 50 tons; 3.64 lbs., 40 tons 4.20 lbs., 30 tons 6.13 lbs., 20 tons 7.00 lbs. These figures represent about the same speed in each case, and with the grade counted in and allowed for.

When we come to curve resistance, there are two aspects presented. One where the train is shorter than the length of the curve and is never on it, in its entire length of cars. The other is where the curve is longer than the train, and the whole train is on the curve only for a short time. If the curve is shorter than the train, the resistance will increase uniformly from the time the head end of the train enters the curve until the head end of the train leaves the curve. Then the resistance will remain constant until the read end of the train enters the curve. When the head end leaves the curve the resistance will decrease just as it increased when the train entered the curve. If the curve is longer than the train, the train resistance having gradually increased during entrance, remains constant while the whole train is on the curve, and gradually decreases as the train runs off the curve. For a freight train weighing 72 tons, gross; the resistance per ton per degree of curvature, with level road may vary between 0.10 lbs. and 1.75 lbs. A fair average for curve resistance at low speeds, on level tracks, is about 8 lbs. resistance per ton, per degree.

In dealing with passenger cars it may be said that the data so far accumulated on this subject show that at the higher speeds at which these cars are run, the combined effect of the journal and the atmospheric resistance undergoes a large increase as the speed increases. The journal friction is greatest at the start, but reaches its minimum at from 25 to 30 miles an hour. It is then constant, or shows a very gradual rise as the speed increases. Atmospheric resistance increases in proportion to the speed, but at low speeds the lower resistance due to slow speeds, is partly offset by the lower resistance of the journals when the train is gaining speed. The combined effect of wind and journal friction rapidly increases as the speed gets above 25 or 30 miles an hour.

With, say, 65-ton passenger cars, a table worked out from tests made, shows that at a speed of about 30 miles an hour, the resistance is between 4 and 5 lbs., at 40 miles an hour, it is between 5 and 6 lbs., at 50 miles an hour it is 7 lbs., at 60 miles an hour it is 8½ lbs., at 70 miles an hour 10½ lbs., and at 80 miles an hour it is 12¾ lbs. The only difference between four wheel and six wheel trucks carrying approximately each the same weights, is due to the six wheel trucks being heavier than the four wheel trucks. The larger trucks added slightly to the gross weight of the car filled with passengers. In general it may be said that practically, scarcely any difference in the resistance of passenger cars of equal weight, exists by reason of the different kind of trucks upon which they are carried. The supposition, formerly in vogue, that for equal car weights having the greater number of journals, having greater resistance, is not sustained by this test. Practically the resistance of equal weight cars is not altered or affected by the four wheel or the six wheel truck.

To handle the pulling of cars, which is the real work of the locomotive engine, complicated, as it is by the resistances to which reference has been made, we have, and must have, the essential of satisfactory performance, and that is continuous draw-bar pull. This expression has been defined to mean that it is the intensity of the pull that the engine exerts on a train, measured from the rear of the tender, and that the engine can maintain for one or more hours, continuously, speed conditions being the same. This draw-bar pull is usually given for straight, level tracks, and necessarily will have to be stated in accordance with the grades and curves encountered. Some recent designs of P. R. R. locomotives are such that 10 lbs., of water per square foot of heating surface per hour, can be exaporated. The resulting amount of steam is practically constant for all speeds; therefore, the draw-bar pull will vary with the speed. The starting power of the engine can usually be maintained almost constant up to 12 or 15 miles an hour, after which it gradually reduces to ⅝ of the starting power at 25 miles an hour. The question of continuous draw-bar pull is very largely a boiler question and that demands considerable attention now-a-days. An ample boiler is always good, but a large well-proportioned carefully-designed boiler, taking advantage of the numerous scientific aids to be had, is better.

Electrification in Sweden.

It is calculated that had Sweden's railways been electrified before the war their cost would have been paid for by the money that has been expended in the present year for coal. Seven power stations are available, namely, Lagan, Göta Alv, Motala Ström, Dalälven, Indalsälven, Emeå Alv, and Luleå Alv. The supply of power is under governmental control. It is calculated that power for agricultural purposes could be delivered from the railway supply.

Efficiency in the Use of Fuel Oil

The Bureau of Mines is doing excellent work for the conservation of fuel by publishing numerous hand books and circulars especially for the use of boiler plant and locomotive engineers. Among those who have never had the opportunity of observing the amount of care necessary in the use of oil fuel it is not uncommon to meet many who think that on locomotives burning liquid fuel the fireman has nothing more to do than open the valve admitting the oil and that the burners do the rest. On most of the railroads where fuel oil is in use special instruction circulars are furnished setting forth in detail the operations necessary from the starting

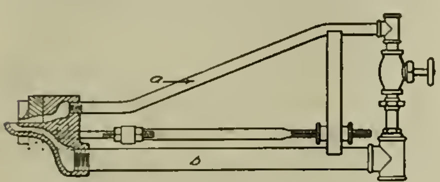


FIG. 1.

of the fire when the firebox is cold to the giving up of the engine at the end of the run when all hands are going away from the engine. Between those periods of starting and stopping the fire should never be entirely out. The fire is, as a rule, started by igniting a piece of greasy waste, then slightly turn on the oil, then open atomizer valve enough to atomize the oil passing from the burner, and the oil will instantly ignite. Care should be taken not to turn on too much oil, for an explosion would drive the flame out of the firebox and might cause more or less injury.

The presence of water in the oil may put out the fire and oil will continue to run into pan and from the pan into the pit; and then if the fire should be rekindled, the lighted oil might start the oil burning in the pan and also in the pit, and set fire to the locomotive. The fire in the engine should be carefully watched until after the engine has commenced making steam, when there is little or no danger of any bad results. Fire going out on an oil-burning engine can be detected readily by smoke coming out of the stack. It is of a white, milky color, and indicates that the fire has gone out and that the oil is still running out into the pan.

Firing up oil-burning engines at places where there is no steam available, it is necessary to fire up with enough wood to raise steam pressure required in the boiler to work the atomizer. Care should be exercised by the operator in throwing wood into the box, not to injure the brick wall, nor arch, and care should be exercised by the engineer starting out of a terminal with an oil-burning engine which has been fired up with wood to see that there are no sparks to endanger the equipment and objects in the surrounding country.

It is very important that the proper amount of steam be admitted to the burner as an atomizer. It is also very important that brick walls and arches should be kept in perfect condition. Occasionally small pieces of brick may fall down and lodge in front of the burner and interfere with the engine steaming.

In oil-burning engines it is necessary to occasionally use sand for cleaning the gum off the end of the flues in the firebox. The sand is applied through an elbow-shaped funnel made for the purpose. The nozzle of the funnel is inserted through an aperture in the firebox door, and when sand is being applied by the fireman the engineer has the reversing lever in the bottom notch and has the throttle valve wide open. This is very effective in inducing a sharp blast of sand against the flue ends and through the flues.

In handling oil-burning locomotives on the road the engineers and firemen both work in harmony. When an engineer is about to shut off steam, he should notify the fireman in time so that the latter may reduce the opening in the oil valve and prevent the waste of oil and the blowing off of the safety valves; and again, in starting up, the engineer should notify the fireman, so that the oil valve may be fully opened and the fire burning brightly before any cold air is drawn into the firebox by the exhaust. In opening the oil valve it should be gradually increased as the engineer increases the working of the engine. The careful manipulation of the oil and steam valves at this time will in a great measure prevent leaky flues. The firebox also can be easily damaged by over-firing. In an oil-burning engine the fire can be raised so rapidly that there is danger of overheating the plates and damaging the firebox. The proper method is to handle the oil valve so that as much time may be consumed in raising the steam to the desired pressure as in the firing of a coal-burning locomotive.

Improvements have been effected in recent years both in the appliances used in oil-burning and in the purity of the oil itself. The greater proportion of the oil fuel now burned is known as reduced crude or residuum. Formerly crude petroleum was burned, but as this has a low flash point and is unsafe to handle, because of its containing the more volatile hydrocarbons, and as it contains considerable water, its use has been largely abandoned. The present practice is to remove the lighter hydrocarbons and the water by partial distillation, thus raising the flash point, recovering the valuable light products, and reducing the water content to an allowable percentage.

Regarding atomization and burners, the function of any burner is to atomize and finely divide the oil so that the oil particles will present the maximum of surface for contact with the air required for combustion. Usually the air is admitted around the burner. The proper position of air ports and the method of admitting the air are of prime importance, slight changes often having a startling effect on the fire. In general the cooling effect of a large volume of air should be avoided as much as possible.

For effective atomization of fuel oil, the viscosity must be reduced by heating. Certain oils now marketed have to be heated above the flash point in order to attain this viscosity, consequently the hazard in handling them is increased. The capacity of the burner increases as the oil is heated to a certain temperature, determined by the viscosity and the expansion relation, but with further increase of temperature the capacity steadily decreases. The operator should always know the temperature to which the oil is being heated and govern the conditions according to the oil.

The oil is usually heated by steam, and preferably by exhaust steam which has a heat content that is nearly as great as live steam and at many plants would otherwise be wasted. The immense amount of heat latent in exhaust steam is so rarely utilized that the advantage of utilization needs to be emphasized repeatedly. Steam atomizing burners are of two types—the outside mixing and inside mixing. In the outside type the steam and oil leave the burners from separate nozzles and are

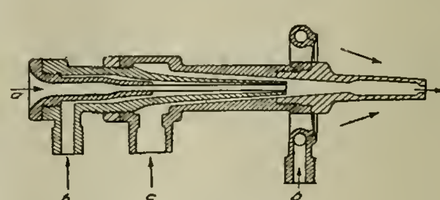


FIG. 2.

mixed directly in the combustion chamber. The burner shown in Fig. 1 is used rather widely on locomotives. The steam is directed across the oil jet and creates a suction effect that aids the atomization. Fig. 2 shows a burner of the inside type. The steam enters the mixing chamber through a central nozzle and thus induces the flow of oil. Air is also drawn into the chamber through a small central passage; this air hastens combustion and the central passage facilitates the cleaning of the burner. The outside ring of steam jets is for inducing a sufficient supply of air and directing this where needed.

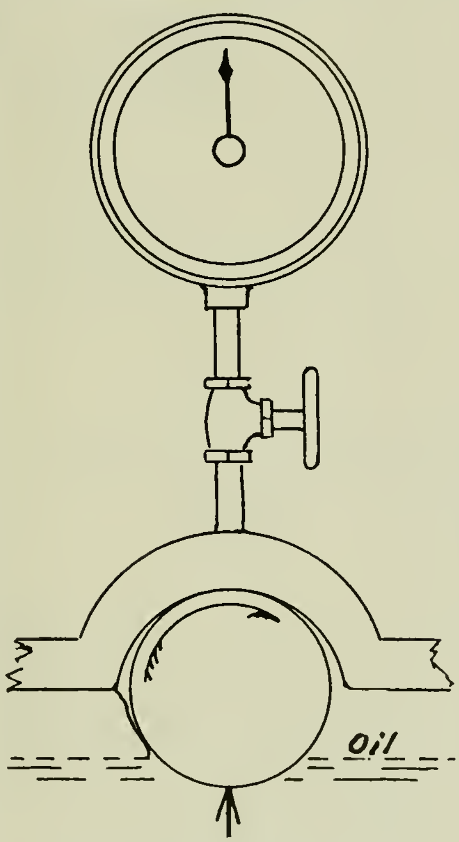
Causes of Improper Lubrication

Tower's Device for Showing the Pressure on the Oil Film

From expert opinions advanced by several traveling engineers it is claimed that the problem of valve and cylinder lubrication is not so much in the choice of the oil used as it is in the degree of success attending the effort to prevent the admission of air and smokestack gases. This cannot be accomplished by the use of automatic devices, for sooner or later they will fail. It is necessary to secure the co-operation of the engineer to keep the cylinder filled with steam at a pressure above that of the atmosphere at all times when the locomotive is drifting. So far this has depended on the intelligence of the engineer. A drifting valve may be produced that will be so positive in its action that with a reasonable amount of attention on the part of the engineer it may be depended upon to open and close automatically at the proper time. When this valve is in action it must admit varying amounts of steam to the cylinders to take care of the demands of varying speeds.

The general causes of improper lubrication may be summed up as comprehending the improper operation of the locomotive; poor maintenance of valves, pistons, crossheads, lubricators, or to a poor grade of oil. Investigation of a large number of cases in which defective lubrication has been reported, indicates that the relative importance of their causes of lubricating troubles is in the order stated. The failure to use steam while drifting down grade or in bringing the train to a station stop, is, of course, the most frequent cause of poor lubrication, but the improper maintenance of pistons, valves, bull rings, packing rings and even of guides and crossheads, has been a prolific cause of lubricating troubles. To secure satisfactory results, the guides and crossheads should be lined up to the center line of the cylinder, while piston and valve bull rings must be maintained as close to the size of the valve and cylinder bushings as the expansion of the metal will permit. The closer the bull rings fit the cylinder bushings, the less stress is thrown on the packing rings and the longer the packing will last. It is very important that the bore of valve bushings and cylinders be correctly maintained, and if this is done, ordinary snap packing rings will give satisfactory service. All packing rings should be roughed out before they are cut and should afterwards be placed in a jig and turned to the exact size of the bushing. In case the cylinder and valve bushings are out of round, it is not possible to maintain the packing steam tight if the ordinary snap rings are used. While a good grade of cast iron has given satisfactory service in packing rings or cylinder and valve bushings, a number of railroads have increased their cylinder packing mileage greatly by the use of a special gun metal for these parts. The importance of the correct maintenance of pistons, valves and cylinder bores cannot be exaggerated.

The lubrication of the main journal of the modern locomotive calls for careful consideration, both because of increased weights and exacting demands in service. A passenger locomotive of fifteen years ago, with a tractive force of say 16,000 pounds, could handle a light train between Chicago and New York in say thirty hours. Today the same service requires a locomotive of 300,000 pounds, with a tractive force of 30,000 pounds, capable of hauling the heavy all-steel train in twenty hours at all seasons and always without delays. In like manner freight locomotives have developed from a tractive force of 25,000 pounds to the Mallet articulated compounds, with tractive force of 100,000 pounds, weighing 450,000 pounds.



TOWER'S DEVICE FOR SHOWING THE PRESSURE ON OIL OR GREASE IN A JOURNAL BOX.

Claims have been made that the heavy demands on journals and the necessity of keeping them in cool running condition, a properly compounded grease is safer in operation than by the use of oil, no matter how carefully the latter may be applied. From the experiments of Beauchamp Tower, a British engineer, the "film of oil" theory was established. The instant that this film is broken and metal touched metal, all laws of lubrication failed. Mr. Tower's experiments also show that there is a best lubricant for every class of service, ranging from the heavy oils and greases, with high viscosity or "body" for great pressures, and low velocity of rubbing, to the light spindle oils for low pressures and high velocities. Good judgment based on experience is the best guide in the selection of the proper oil for each service.

The results of some of Mr. Tower's experiments are interesting. In the accompanying drawing is shown a simple device showing the pressure on the oil or grease film in a journal box. A hole was drilled in the cap of the box for the purpose of applying oil at that point. It was found that oil would not enter there, and a bath was applied below the box, inserting a wood plug in the hole. But this was always forced out by the oil. Mr. Tower then connected a pressure gauge and found that while the pressure on the journal was 100 lbs. per square inch, the pressure gauge recorded an oil pressure of over 200 lbs. per square inch. Apparently the journal with oil adhering to its surface serves as a pump constantly lifting oil to the top. The adhesion of the oil to the surface made it possible for the pressure at the center to reach this very high point. The importance to be attached to this is that journal boxes should be constructed so as to admit of the pumping of the lubricant up the side to the top. It is readily conclqded that if an ample supply of lubricant can be maintained between rubbing surfaces of fluid pressure twice as great as the unit pressure on the journal, there need be no concern as to the failure of the film separating the metals.

Rust Preventing Varnish

Resin six parts, sandarac nine parts, gumlac three parts, turpentine six parts, and rectified alcohol nine parts. The resin, sandarac and gumlac should be mixed together in a pounded condition, and then carefully heated until melted. When they are well melted, the turpentine should be added very gradually, stirring all the while. The mixture should then be digested until dissolution takes place. Then add rectified alcohol up to the amount stated above.

Correct Alignment of Locomotive Parts Necessary to Maximum Service and Minimum Wear

It may be set down as a general principle in locomotive construction that, as in all construction work, to begin carefully and correctly is of vital importance. In many division point railroad shops there are many new, or next to new, locomotives built that will compare favorably with locomotives constructed elsewhere, and it must be remembered that the work is not always done under the best conditions. In the leading locomotive works there is a precision in ways and means that is rarely departed from. A prearranged schedule is maintained. In the roadside shops the work is itntermittent, and the work usually begins with an attempt at a dramatic flourish of getting the frames and boiler and saddle and cylinders together as rapidly as possible with a view to gratify the eye of some higher authority. If the general foreman was let alone there would be no such tremendous haste at the start, and there might be less trouble later on. A consensus of opinion among shop foremen

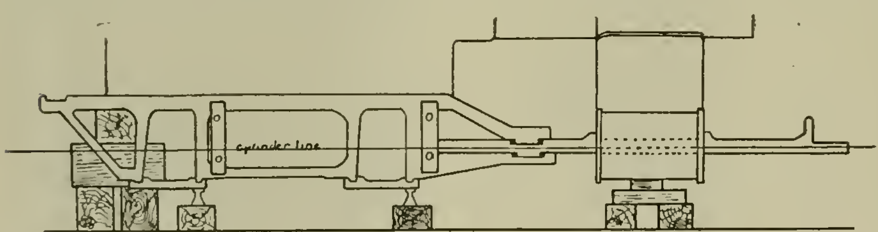


FIG. 1.

found expression at a meeting of the International Railway General Foremen's Association, in which a few simple instructions were tersely presented in regard to locomotive instruction, and which contain much that should be of value to those aiming at good practice and economical results.

Beginning with the boiler, level the center line till in a horizontal position. Level the firebox till the vertical center line is vertical. The cylinder saddles should be fitted to locate the center line parallel to the center line of the boiler, regardless of the smokebox, with back cylinder faces at right angles thereto. The alignment of the frames should be at right angles to the back joint faces of the cylinders, and consequently parallel to the center lines thereof, as shown in Figs. 1 and 2.

Square jaw centers on frames for shoes and wedges, so that driving boxes and axles will be square or at right angles with cylinder line, and when this operation is carefully and thoroughly done, we may consider that at least in part we have laid the foundation for a good engine, but we are not by any means finished. There are quite a number of different methods used in squaring the shoes and wedges with the object in view of bringing the wheels square with the frames and cylinders,

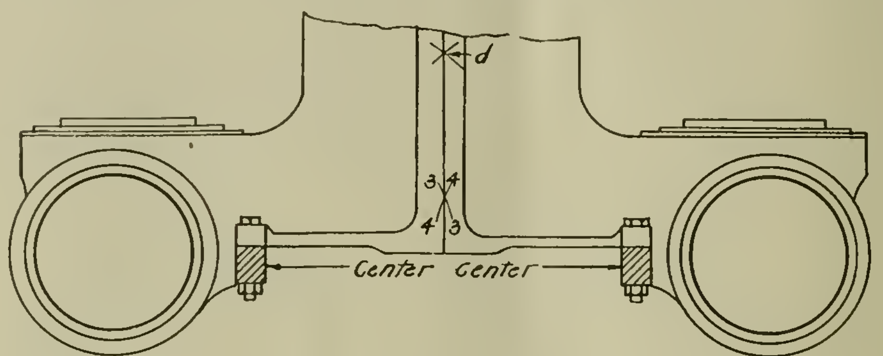


FIG. 2.

among which are stretching a line drawn through the cylinders and made central to the counter bore of each end of the cylinder and running well back of the main jaws. A straight edge is then placed across the main jaws at perfect right angles to the line, using a true two-foot square along the straight edge and allow it to "feel" the line which is drawn through the cylinders, as shown in Fig. 3.

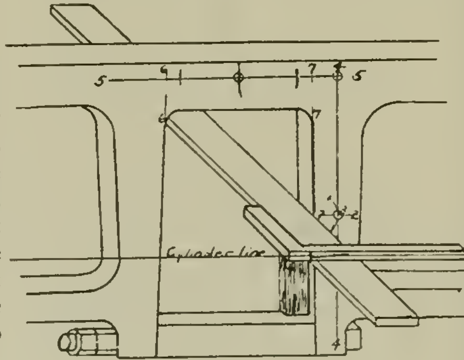


FIG. 3.

If the square does not show exactly parallel with the line it will then be necessary to place shims between one of the jaws and the straight edge until the straight edge shows exactly at right angles with the line drawn through the cylinder centers. After this has been perfectly accomplished draw a vertical line down square with the top of the frame and let the blade of the square "feel" the edge of the straight edge and this line will be what is termed as the square line, and from this line should be drawn down on each frame a vertical line equi-distant on each frame. From this line we locate the centers, and with trams set to rod lengths, centers in the main jaw, and from these the centers on the other jaws are located.

After these centers have been obtained we will lay off half the diameters of our boxes on each side of the centers, and after the shoes and wedges have been placed in position, with binders tight, draw vertical lines down the shoe and wedge, half the diameter of the box plus one inch. This line is used for setting up shoes and wedges on the planer, and if the markings are carefully made this method will serve the purpose well.

Regarding the center casting it should be located exactly central between the frames, as the truck leads the engine, and even if the engine is correctly lined and the center casting is not central, or the truck not properly lined, to a certain extent it will be impossible to rectify the errors. There are, however, various ways or methods used for lining shoes and wedges, such as a "fish-tail" tram, from the center casting, or a tram on points 3 and 4, on Fig. 2, to locate a center on each side of the main jaw, or a three-pointed tram from a center between the frames, or the back end of cylinder saddle, but the object is the same, and opinions naturally differ as to which method or means is the best. One question all should agree on is that the work cannot be done too carefully. Any deviation from the exact squaring and marking and planing to the lines is sure to invite driving box and rod brass trouble, and also the cutting of tire flanges. All parts of the engine should fit snugly, but should

go into place without strain if maximum service and minimum wear is aimed at.

Other causes of trouble arise from hurried or careless adjustment of springs, saddles and boxes. Evidence of this may be seen in any repair shop. Some boxes are worn on the top and some on bottom of the sides next to the wheel, indicating unevenly worn brasses. In many cases the saddle seats on the top of the boxes are uneven and not square with the planed surfaces of the box. Spring hangers and saddles may be fitted and machined exactly as desired, but it is not unusual to note a difference of half an inch in the thickness of the brasses. Hence the driving boxes are out of square and carry unequal weights and are an additional cause of unnecessary friction.

Special care should also be taken in the alignment of the guides both horizontally and transversely. This is to take care of undue friction in piston packing and piston rings. If this is done as it should be it will add to the life of the rings, as well as the packing and piston rod. It need hardly be added that the valve motion should be maintained in correct adjustment, the worker, careful not to fall into the error of having too much lead, and noting carefully that as much steam is used on one side of the engine as on the other. The point of cut-off should be correctly maintained, as any serious irregularity in the use of the steam, even though the valves may be square at the opening points, will cause an unsteady motion and contribute perhaps to the breaking of the frames or other avoidable fracture. The valve gear should be gone over as often as an opportunity may afford.

What Is Boiler Lagging and What Does It Do?

Wood, Plaster, Hair-Felt, Magnesia-Carbonate, Asbestos and Other Air Resisting Material

Every man in the locomotive department knows the importance of the "lagging" that surrounds the boiler, but very few men have seen it in modern form, or know of what it is composed. Suppose we take a peep underneath the outer sheet-iron jacket and find out what this lagging is made of, and what it does. Locomotive operating conditions are severe. Even in the hottest weather, the continual rush of air has a tendency to rapidly cool the outer surface of the boiler. In winter time blizzards and below-zero weather, most efficient firing is required to keep up a head of steam against waste of heat.

Many materials have been tried for this purpose. In the earliest days the lagging was of wood. Later, various forms of plaster, hair-felt and other non-conductors were tried, but with the constant rise in pressure and in the size of the locomotive, these finally proved to be ineffective. Very many modern American locomotives are lagged with the heat-insulating material known to the trade as "85 per cent. Magnesia." It is composed, as the name implies, of 85 per cent. magnesia carbonate with 15 per cent. fibrous material, chiefly asbestos, which acts as a binder, in the same way that hair in lime plaster does. The "85 per cent. magnesia" is applied over the outer shell of the boiler in the form of a double layer of blocks, usually 6 ins. long by 36 ins. wide. The second layer is laid so that it breaks joint with the first and the intervening spaces are filled with a plastic cement, composed of the same material, the whole being securely held in place with a heavy iron wire. The total thickness of the double layer is about 2¼ ins. Over all, comes the sheet iron outer jacket which appears as the solid boiler, but is in reality little more than what the wrapping paper is to the parcel it covers.

What is the vital principle of this and other suitable coverings that makes them the efficient heat insulation for locomotive purposes? The answer is "dead air." Air in rapid motion speedily cools a heated object. Even a child will blow on its hot meal to cool it. Thus we come in contact with the great natural principal of "convection," which with radiation and conduction are the three great sources of heat loss.

But the exactly opposite conditions also apply here. "Dead" or stagnant air is a powerful heat retardant or non-conductor. Therefore, the more "dead air" a substance contains the poorer a conductor of heat it is. Metal or stone are homogenous and close-textured, and so are good conductors. Brick and wood are most porous, resist, to a certain extent, the passage of heat. Wool and feathers keep the bodies of animals and birds warm simply because of the large amount of dead air enmeshed in them. They are among the best non-conductors, but obviously could not be used for boiler covering under modern strenuous conditions with their high pressures and temperatures. Doubtless if locomotives grew feathers or hair this would form an ideal lagging, but there is a great difference between the live substance growing on an animal and the application of a dead material to a metal surface.

Fortunately we have in good insulating material not only resistance to high temperature, but also the large amount of minute particles of dead air, imprisoned in the microscopic, crystalline cells of the substance itself, and this substance shows no tendency to disintegrate under the constant shocks to which a rapidly moving locomotive is subject. The apparent lightness in weight of a block of the magnesia lagging is caused by the enormous quantity of dead air it contains. So small are the air cells, however, that a microscope is needed to discover them. This is the secret of the great heat resisting powers of good boiler covering. While larger air cells would permit a certain amount of circulation and consequent loss of heat, the minute cellular structure of the magnesia, effectively locks up the air particles so that they cannot part with their heat to each other or to the colder air outside.

This brief reference to locomotive boiler lagging is primarily intended for the men who have to work with and live with various appliances for locomotives and, in fact, have to make each of them "go." A boiler with high steam pressure requires a thicker layer of lagging than one having a low pressure. The proprietors of the lagging are the best authorities on how much, and what size, should be used, but the theory of the working of an appliance and what good it is, should be in easy reach of all grades of the service, because the education of a workman in "how to do it," is a direct asset to the seller of an article, as well as to the railway who employs him.

There are many instances on record where this form of insulation has been applied to a new steam installation, and has remained in constant service until the pipes and boilers were worn out and scrapped, perhaps twenty-five years later. When the coverings were removed, they were, however, found in perfect condition and were replaced on the new work.

Perhaps the reader of these lines will never be called upon to specify a lagging or heat insulation for any purpose. Even if he should not, it will do him no harm to know why it is needed and just what it does. The subject is often lost sight of or treated as a matter of little importance, but in view of the rapidly mounting cost of fuel and its probable scarcity for many years to come, it is a subject that deserves, and is likely to receive, far greater attention in the future. What is known as publicity properly handled and with an educational value is of great importance.

The plain statement of a clearly ascertained fact in this work-a-day always carries with it a useful quality that people look for and expect.

New Switcher and Mikado Locomotives for the Great Northern Railroad

The Great Northern Railroad has recently received a number of heavy locomotives of the 0-8-0 and 2-8-2 (Mikado) types from the Baldwin Locomotive Works. The former is a new type on this road, while the latter has been used in freight service since 1911. The two types are in many respects similar, and are equipped with interchangeable details as far as practicable.

The 0-8-0 locomotives are used in heavy switching service, and exert a tractive force of 58,700 lbs. The ratio of adhesion is approximately 4, so that the weight on drivers is fully utilized. The high tractive force is backed up by liberal steaming capacity, thus fitting these engines, not only for yard duty, but also for transfer and other special service where runs of some length must be made. The locomotives are designed to traverse curves of 20 degs.

In accordance with Great Northern practice, these locomotives have Belpaire boilers and Emerson superheaters. The crown and roof sheets of the inside and outside fireboxes are arched transversely to a long radius, and the staybolts are radial to both sheets. The backhead, above the crown, is stayed by gusset plates. The large superheater flues are arranged in eight vertical rows, which are grouped in four pairs, and the headers are placed vertically in the smokebox. There are no superheater flues in the lower part of the boiler barrel, as was the case in some earlier designs of Emerson superheaters.

In addition to the main throttle, there is an auxiliary valve in the cab, which can be opened while drifting. This valve has a 1½-in. pipe connection with the steam-pipe cone in the smokebox. By-pass valves, of a type extensively used on the Great Northern, are applied to the cylinders. This valve consists of a flat plate, which rests on a horizontal seat having ports in it that communicate with the live steam passages at the two ends of the cylinder. When the throttle is open, the plate is held on its seat by steam pressure acting on its upper surface. When drifting, pressure on the under side of the plate will cause it to rise from its seat, thus opening free communication between the two ends of the cylinder.

The steam distribution is controlled by 13-in. piston valves operated by Walschaerts motion. The gears are controlled by the Ragonnet power reverse mechanism.

The illustration of locomotive No. 3087 shows the general design of the Mikado type, of which a total of 145 have, up to the present time, either been built or ordered. These locomotives exert a tractive force of 60,900 lbs. As far as their principal features are concerned they are all of similar construction, but the original design has undergone extensive revision in the locomotives more recently built. The tractive force developed is fully up to the limits of the adhesion; while with driving wheels 63 ins. in diameter, the locomotives have good speed capacity.

In general design, the Mikado type boiler is similar to that used on the switchers, but it is of considerably greater capacity. These locomotives are stoker fired, the Street stoker being used on locomotive No. 3087; while the Duplex type is being applied to the more recent engines of this class. Labor-saving devices further include a power operated grate shaker and a coal pusher on the tender. The auxiliary dome is placed forward of the firebox, and is mounted over an inspection man-hole, so that the boiler can be easily entered without dismantling the throttle rigging in the main dome. A drifting throttle valve and cylinder by-pass valves, are applied as in the case of the switchers.

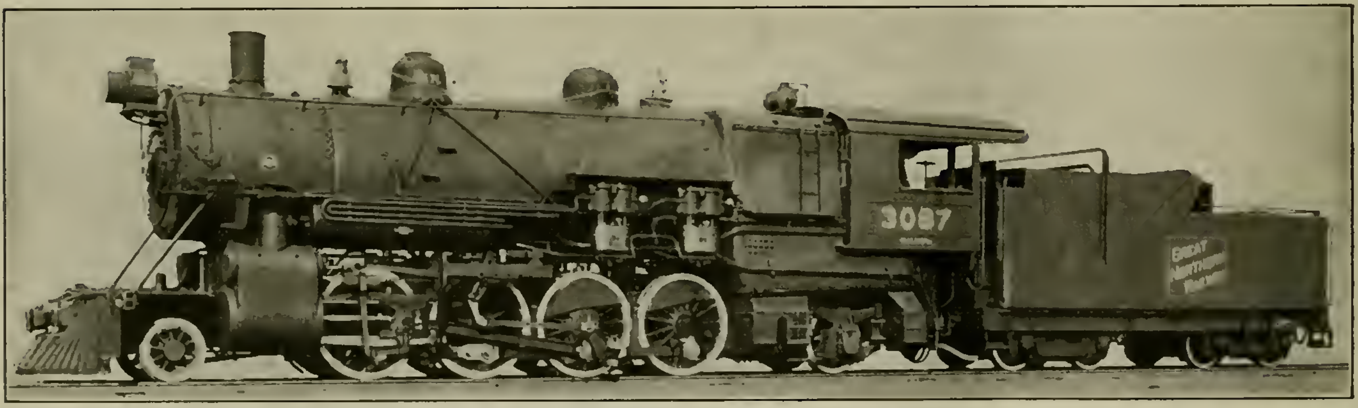
The Walschaerts valve motion has been used on all these locomotives, with the exception of five, on which the Southern valve motion is specified. Running gear details include the Hodges design of trailing truck, which is used on all the Great Northern Mikados.

The tender is carried on rolled steel wheels, and the tender trucks are of the equalized pedestal type. The frame is built up, and is placed as low as possible, in order to keep down the center of gravity to as low a point as possible.

The principal dimensions of both these types of locomotives are given in the tables. The first given is the switcher, the Mikado following.

Switcher.—

Gauge 4 ft. 8½ ins.; cylinders, 26 ins. x 28 ins.; valves, piston, 13 ins. diam. Boiler.—Type, straight Belpaire; diameter, 80 ins.; thickness of sheets, 13/16 ins.; working pressure, 200 lbs.; fuel, soft coal; staying, radial. Fire Box.—Material, steel; length, 118 ins.; width, 72¼ ins.; depth, front, 75¾ ins.; depth, back, 65⅜ ins.; thickness of sheets, sides, back and crown tube, ⅝ in. Water Space.—Front, sides and back, 5 ins. Tubes.—Diameter, 5½ ins. and 2 ins.; material, steel; thickness, 5½ ins., No. 8 W. G.; 2 ins., No. 11 W. G.; number, 5½ ins., 36; 2 ins., 234; length, 15 ft. Heating Surface.—Fire box, 207 sq. ft.; tubes, 2,597 sq. ft.; total, 2,804 sq. ft.; superheater, 651 sq. ft.; grate area, 59.2 sq. ft. Driving Wheels.—Diameter, outside, 55 ins.; journals, main, 11 ins. x 16 ins.; journals, others, 10 ins. x 12 ins. Wheel Base.—Driving and rigid, 15 ft. 6 ins.; total engine, 15 ft. 6 ins.; total engine and tender, 51 ft. 0¾ in. Weight.—On driving wheels, 232,600 lbs.; total engine, 232,600 lbs.; total engine and tender, about 360,000 lbs. Tender.—Wheels, 8; wheels, diameter, 33 ins.; journals, 5½ ins. x 10 ins.; tank ca-

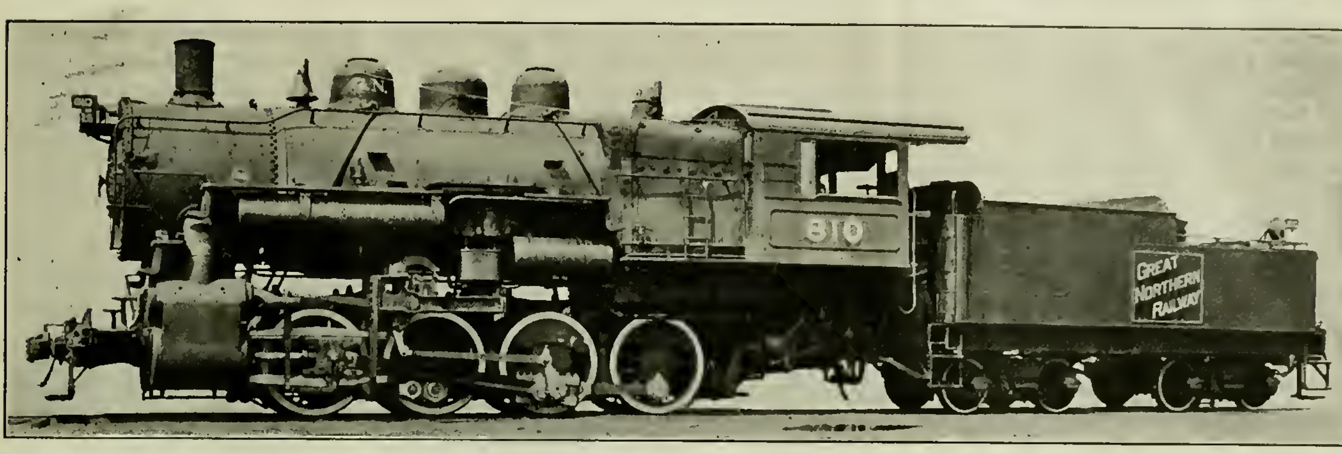


A. C. Deverell, S. M. P. GREAT NORTHERN MIKADO TYPE 2-8-2 LOCOMOTIVE Baldwin Loco. Works, Builders.

pacity, 6,000 U. S. gal.; fuel, capacity 12 tons; service, switching.

Mikado.—

Cylinders, 28 ins. x 32 ins.; valves, piston, 13 ins. diam. Boiler.—Type, Belpaire; diameter, 82 ins.; thickness of sheets, ⅞ in.; working pressure, 180 lbs.; fuel, soft coal; staying, radial. Fire Box.—Material, steel; length, 117 ins.; width, 96 ins.; depth, front, 83¾ ins.; depth, back, 75¼ ins.; thickness of sheets, sides, back and crown sheets, ⅝ in. Water Space.—Front, side and back, 5 ins. Tubes.—Diameter, 5½ and 2 ins.; material, steel; thickness, 5½ ins., No. 8 W. G.; 2 ins., No. 11 W. G.; number of 5½ ins., 36; 2 ins., 304; length, 21 ft. Heating Surface.—Fire box, 252 sq. ft.; tubes, 4,413 sq. ft.; total, 4,665 sq. ft.; superheater, 918 sq. ft.; grate area, 78 sq. ft. Driving Wheels.—Diameter, outside, 63 ins.; journals, main, 11 ins. x 16 ins.; journals, others, 10 ins. x 12 ins. Engine Truck Wheels.—Diameter, front 33½ ins.; journals, 6 ins. x 11⅞ ins.; diameter, back, 42½ ins.; journals, 8 ins. x 14 ins. Wheel Base.—Driving, 16 ft. 9 ins.; rigid, 16 ft. 9 ins.; total engine, 35 ft.; total engine and tender, 68 ft. 1 in. Weight.—On driving wheels, 229,000 lbs.; on truck, front, 25,400 lbs.; on truck, back, 52,100 lbs.; total engine, 306,500 lbs.; total engine and tender, about 460,000 lbs. Tender.—Wheels, diameter, 36 ins.; tank capacity, 8,000 gals.; fuel, 13 tons; service, freight.

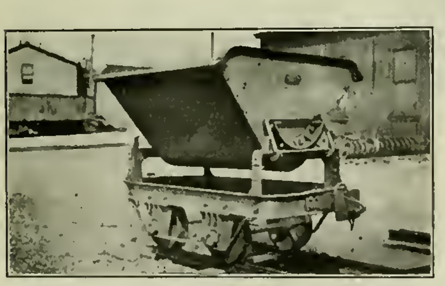


GREAT NORTHERN SWITCHER OR 0-8-0 TYPE LOCOMOTIVE.

A. C. Deverell, S. M. P. Baldwin Loco. Works, Builders.

Five Hundred Steel Dump Cars for France

Five hundred rocker dump cars having a capacity of 27 cu. ft. are now being delivered to the French Government by the Youngstown Steel Car Company of Youngstown, Ohio. These cars were built for the transportation of various loose materials, such as crushed stone, concrete, sand, excavated soil, coal, ashes,



AMERICAN STEEL ROCKER-DUMP CAR FOR FRANCE.

etc., and are most desirable for automatic unloading.

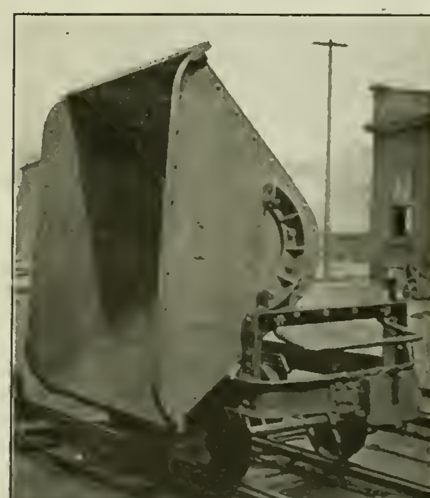
The cars are all steel construction and can be used for light locomotive traction. They are very strong yet light in weight, being about 1,050 lbs. each. They dump very easily and discharge contents clear of underframe and rails. By carefully proportioning the body, there has been obtained a steep angle of dump and the car will empty its contents completely.

The body is locked in its normal position by a locking bar hinged to the gusset-plate on one of the rocker races. The bar is swung into position over the rocker, and is held in place by a pin which passes through the upper flange of the rocker. The car is prevented from overturning by safety bars at the outer edge of the rocker race.

The frame is composed of steel channels bent to form a round bumper at the ends—a construction that is simple as well as strong. At the ends, the sills are connected together on the inside with a splice plate which is flanged to cover the bottom and top flanges of the channel.

The draft gear is of the French type, steel drawbars and buffers, with wrought steel link and coupling pin. The cars are equipped with cage roller bearings enclosed in gray iron boxes, which are attached to the sills by gray iron pedestals. The method of attachment allows the boxes to adjust themselves to any small variation in the position of the axles, due to rough track, etc. The wheels are 14 ins. dia., gray iron with chilled tread and flange and weigh about 50 lbs. each, pressed on axles with about 8 lbs. pressure.

As these cars were for export, careful consideration was given to the design in order to facilitate packing. The ends of the hopper were slightly tapered to allow them to be nested for foreign shipment. Cars were shipped in one hundred lot shipments, consisting of seventy packages. There were five underframes to a package, packed to form a box to hold all accessories for five cars, such as couplers, pedestals, journal boxes, bearings, washers, bolts, etc. The gross weight of each



TYPE OF STEEL ROCKER-DUMP CAR FOR FRANCE.

package of underframes was 53,240 lbs. The bodies were packed ten to a package. The gross weight of each package of bodies was 2,940 lbs. The wheels were packed with five pair of wheels to the package, gross weight 680 lbs.

Bearing Power of Chilled Iron

By F. K. VIAL, Chief Engineer, Griffin Wheel Co.

The effect of a wheel on a steel rail when carrying a load is to produce an indentation into the surface metal, the depth of which is determined by the diameter of the wheel, the width of the bearing surface and the amount of load. The relation of these items and also the area of contact between wheel and rail and bearing pressure per square inch were determined in a series of tests conducted by the Griffin Wheel Company in the R. W. Hunt testing laboratory, with the following results:

An important item in the above results is the reduction in depth of penetration of wheel into the metal of the rail when the length of bearing is increased. This feature is made use of in crane service where loads in excess of 100,000 lbs. per wheel are not uncommon; special rails with a wide bearing surface are rolled for this purpose.

The bearing power of chilled iron is such that the wheel does not flatten perceptibly under any load below 250,000 lbs. The metal does not crush nor flow under any load which the rail will support, consequently the deformation to the surface metal of the rail is at a minimum, for it is self-evident that if the metal in the wheel should crush and flow this action in itself would produce a tendency to deform the metal in the surface of the supporting rail. This action does not exist in chilled iron.

TABLE 1—BEARING OF 33-IN. CHILLED IRON WHEEL ON A RAIL HAVING A 12-IN. TOP RADIUS.

Load.	Area of Contact.	Penetration in Rail.	Pressure per Sq. In. of Contact.
5,000	.072	.00081	69,700
10,000	.114	..00129	87,800
20,000	.203	.00229	98,500
50,000	.436	.00492	114,800
100,000	.777	.00865	128,800
150,000	1.089	.01229	137,800
200,000	1.383	.01560	144,600
250,000	1.667	.01888	150,000

The effect of diameter of the wheel on the depth of penetration into the rail under various loads is shown in Tables 2 and 3.

TABLE 2—BEARING OF WHEELS ON 85-LB. RAIL WITH 8-IN. TOP RADIUS UNDER 200,000-LB. LOAD.

Wheel.	Area Contact.	Depth of Penetration.	Permanent Set in Rail.	Mean Pressure.
15-in. straight tread chilled iron..........	1.30	.027	.009	153,800
20-in. straight tread chilled iron..........	1.34	.0212	.0115	149,200
33-in. straight tread chilled iron..........	1.35	.018	.009	148,100
33-in. M. C. B. chilled iron................	1.60	.024	.0107	125,000
ON 85-LB. FLAT TOP RAIL 2-IN. WIDE—UNDER 200,000-LB. LOAD.				
15-in. straight tread chilled iron..........	1.60	.0107	.011	125,000
20-in. straight tread chilled iron..........	1.68	.0089	.001	119,000
33-in. straight tread chilled iron..........	1.93	.0071	.001	103,600

TABLE 3—BEARING OF STRAIGHT TREAD CHILLED IRON WHEELS ON STANDARD 85-LB. A. S. C. E. RAIL UNDER 100,000-LB. LOAD.

Diameter of Wheel.	Area of Contact.	Depth of Penetration.	Permanent Set in Rail.	Pressure Per Sq. In. on Area of Contact.
12	0.737	0.0138	0.0068	135,800
16	0.745	0.0121	0.0051	134,200
20	0.753	0.0109	0.0039	132,800
24	0.761	0.0101	0.0031	131,400
30	0.769	0.0091	0.0021	130,000
33	0.777	0.0088	0.0018	128,800
36.	0.785	0.0085	0.0015	127,400

ON FLAT TOP RAIL 2-IN. WIDE—UNDER 100,000-LB. LOAD.

Diameter of Wheel.	Area of Contact.	Depth of Penetration.	Permanent. Set in Rail.	Pressure Per Sq. In. on Area of Contact.
12	0.950	0.0031	none	105,000
16	0.960	0.0027	none	104,000
20	0.970	0.0024	none	103,000
24	0.980	0.0022	none	102,000
30	0.990	0.0020	none	101,000
33	1.000	0.0019	none	100,000
36	1.010	0.0018	none	99,000

Nowhere are the properties of chilled iron shown to better advantage than in their relation to the requirements of wheel service. The bearing area in contact between wheel and rail is very small, hence the pressure per square inch over this area is very large, requiring a metal having special qualities if the service is to be satisfactory. It must have a maximum bearing power with minimum ductility and a maximum resistance to abrasion, for there is always a certain amount of slippage between wheel and rail which increases as speed is increased.

The relative hardness, bearing power and resistance to abrasion of the various grades of iron and steel are largely regulated by varying the percentage of carbon. Wrought iron, containing no carbon is soft, ductile and wholly unfit for any service requiring high bearing power and low abrasion.

When the carbon in combination with the iron reaches .40 per cent. the alloy is ductile, especially while hot, and has all the qualities required for rolling into various shapes such as angles, channels, I-beams, etc., all of which are classified as structural steel. When the carbon content reaches .80 per cent. there is less ductility and greater resistance to abrasion and the material is suitable for railroad rails, rolled wheels, etc., where a considerable degree of hardness is required to reduce abrasion to a reasonable amount. At 2 per cent. carbon, the hardness has very materially increased and ductility has practically disappeared. The metal is suitable for tool steel.

In chilled iron, the carbon is increased to 3.50 per cent., resulting in a corresponding increase in hardness and resistance to abrasion, hence this material is better adapted than any other grade of iron containing less carbon for carrying heavy concentrated loads on the small bearing areas indicated in the foregoing tables. For this reason chilled iron is pre-eminently adapted to the manufacture of wheels for railway service, as indicated by the twenty-four million now in service in the United States and Canada.

It is interesting to note the changing attitude with reference to the use of chilled iron wheels under the heaviest

railway service, which is observed on locomotive tenders. As the capacity of the tenders reached 7,000 gallons, it was thought the service too severe for the chilled iron wheel, but as the capacity of tenders has increased to 12,000 gallons and more, with a concentrated wheel load of 27,000 lbs., there is a tendency to return to the chilled iron wheel on account of its superior bearing power without the least tendency of the metal to flow or to become out of round. The 950-lb. chilled iron wheel is used quite freely under these loads with entirely satisfactory results.

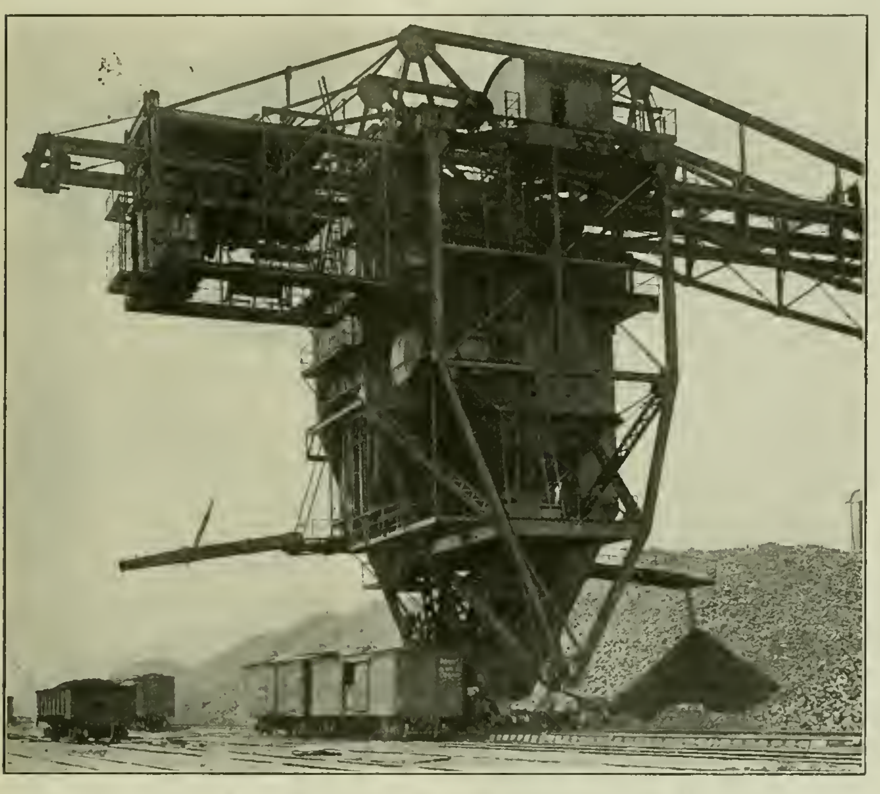
The first permanent set, which indicates passing the elastic limits of the rail, occurs when the indentation or penetration is approximately .007 inch. If we assume that in regular service the wheel load will be such that the indentation shall not exceed one-half this amount, we have the following results for maximum permissible wheel loads in railway service:

On wheels 42 ins. in diameter, load limit 34,000 lbs.; on wheels 36 ins. in diameter, load limit 31,500 lbs.; on wheels 33 ins. in diameter, load limit 30,200 lbs.; on wheels 30 ins. in diameter, load limit 28,800 lbs.

These loads do not indicate nearing the limit of the bearing power of the chilled iron wheel. The limiting loads are based entirely upon the consideration of the bearing power of the rail.

Chilled iron is ideally adapted to the manufacture of wheels for carrying concentrated loads many times greater than permissible in railway service, such as occur in heavy crane service, turntables carrying swing bridges, transfer tables, cantilever moving bridges for unloading large tonnages of ore, coal and various other commodities, where the wheel load often reaches 125,000 lbs. For these heavy concentrated loads special rails are required such as Cambria 150-lb. per yard crane rail, having a flat bearing surface of 3½ ins. Here again the limiting load is the bearing power of the rail. The bearing power of the wheel, which is so much greater than that of the rail, can always be left out of consideration.

The diameter of wheel to be used in these cases is determined by other considerations than the carrying capacity of the wheel. The weights of double flange wheels for crane service run about as follows: 12 ins., 165 lbs.; 16 ins., 250 lbs.; 20 ins., 400 lbs.; 24 ins., 640 lbs.; 30 ins., 875 lbs.; 33 ins., 1,200 lbs.; 36 ins., 1,600 lbs. These are intended for heavy service, with special attention given to flange design, in which sufficient strength is developed to carry a full load over the top of the rail without injury to the flange in case of spreading rails. Large quantities of wheels for this purpose are manufactured and shipped to all parts of the world. They are especially successful for the heaviest cranes used by the Army and Navy.



BROWNHOIST COAL MACHINE—LOAD ON EACH CHILLED IRON WHEEL 105,000 LBS.

Chilled iron is also particularly adapted to the manufacture of rolls for all classes of rolling mill requirements; rolls for grinding refractory materials such as cement, etc., stamp shoes for crushing hard ores and a multitude of other uses where extreme bearing power with minimum resistance to friction and maximum resistance to abrasion are essential. Many foundries are given up exclusively to producing this class of material. The surface of chilled iron is peculiarly adapted to producing a smooth surface on many classes of rolled steel. Rolls for these purposes often weigh 20 to 30 tons each.

The composition of the metal suitable for chilling is practically what is known as semi-steel, although this term has no significance metallurgically. It simply refers to a close grain cast iron of high tensile strength, ordinary cast iron running about 22,000 lbs. per sq. in., whereas it is not at all difficult to produce a grade in which the tensile strength exceeds 40,000 lbs. per sq. in. This material is suited to the production of so-called semi-steel shells of various types. The special advantage is the availability of the material, the greater ease of bursting the walls of the shell, allowing the effect of the explosion to be used against the earthwork instead of being used to burst the shell; also there is greater fragmentation with far greater number of pieces, which is of special advantage when used in the open. Considerable quantities of shells of this material have been made in France and England and also in this country. Far larger quantities might have been made had this subject been taken up in earnest. This indicates a high grade quality of iron of the same variety as used in chilled iron wheels.

In a smaller way a comparatively large quantity of chilled iron is used in the manufacture of wheels for industrial cars, mine cars, gun carriages—in fact, for any purpose requiring the use of wheels.

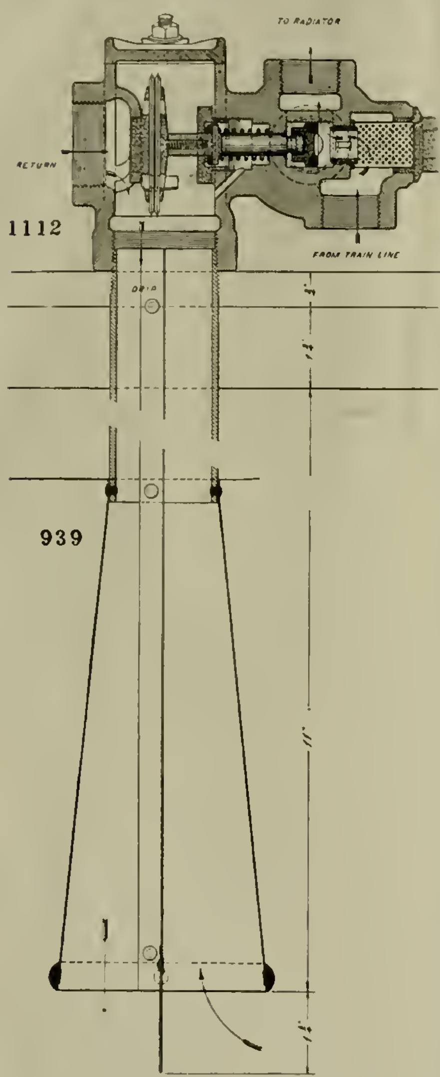
The foregoing indicates the wide adaptation of chilled iron, which is of growing importance. The output in the United States now exceeds two million tons per annum, and as a technical study is made of the properties of chilled iron and its relation to the conditions under which it is to serve, a still wider field will be found and the service in each class will become more satisfactory.

Chicago Car Foremen's Association

The annual meeting of the above mentioned association was recently held at the Morrison Hotel, Chicago, and the following were elected officers for the year 1919: President, E. C. Chenoweth, mechanical engineer, Chicago, Rock Island & Pacific; first vice-president, M. F. Covert, Standard Car Construction Company; second vice-president, James Reed, assistant master car builder, New York Central; treasurer, F. C. Schultz, chief interchange inspector; secretary, Aaron Kline, 841 Lawlor avenue, Chicago.

Gold's New Inside Vapor Valve

The new vapor valve No. 1112 devised by the Gold Car Heating and Lighting Co. of New York, N. Y., has a number of special features which make it superior



GOLD'S NEW INSIDE VAPOR VALVE.

to any underhung valve. It is a vapor regulating valve placed inside the car. It is handy, and its location cannot interfere with other apparatus. If the diaphragm fails from any cause, one side of the heating apparatus in the car can be shut down until the end of the run, or until the inspection point is reached and no blowing of steam results. It is in no danger of freezing and it is not liable to be clogged by dust, or otherwise damaged.

The makers have recognized the fact that the danger from freezing was great, and in constructing this valve they have produced a valve in compact form placing the inlet and all working parts close to the live steam supply. The weight of this vapor valve has been greatly reduced, which including the drip horn is only 16 lbs. "The Straight Push," plan is used here avoiding the use of levers, bell cranks, etc., and the use of packing and a packing-nut on the main stem has been eliminated so as to give this stem all possible freedom when moved by the expansion of the diaphragm.

In place of packing, a disc is used which is held to its seat by the pressure of a spring against the flange on the stem, which spring also serves the purpose of opening the valve, when the diaphragm is in its contracted position. This insures a quick circulation when steam is turned on. The diaphragm is of special design, and very flexible, having expansive qualities sufficient to obviate the necessity of an adjusting screw giving the valve a working range of steam pressure from 1 to 100 lbs.

To get good results from any vapor valve it should be properly ventilated to insure its positive, sensitive working. While it is true a drip pipe leading from the diaphragm chamber if open to the atmosphere at all times, requires some means of forcing the cool air into the chamber. In the drip horn is placed a division or separating wall which runs crosswise of the car and extends down below the horn proper. When a train is in motion or when a cold wind is blowing, a positive draft is forced upward through the forward compartment of the horn. The result of this forced draft cools the diaphragm, causing it to operate promptly, which in itself keeps the radiating pipes evenly heated. Thereby maintaining the greatest efficiency of the radiating surface. The opening to the diaphragm chamber is closed by a cover, held in place by two swing bolts, the cover fits neatly and is steam-tight without the aid of gaskets, so the diaphragm can easily be renewed if desired, and by shutting down the side where the diaphragm is, it can be renewed if necessary while the train is in motion.

In the Gold systems, where this valve is employed steam is fed to the upper radiating pipes; therefore, there is no cooling of the steam by the condensation which has lodged in the radiating pipes as

GOLD'S VAPOR VALVE.

is the case in the so-called "Push Around Systems," where steam is fed into the lower pipes. Therefore, less steam is required to keep the radiators sufficiently heated.

Railroad Men Wanted

The Federal Labor Bureau at Altoona, Pa., has calls constantly for large numbers of artisans, mechanics and laborers. The last list received from the Pennsylvania Railroad specifies 8,087 positions which need to be filled on that road. More than 200 men are wanted in the shops in that city, and 350 laborers on track work. The Cambria Steel Company is looking for 1,100 men, mostly laborers, and the call comes from many factories.

Henry Ford and Production

In an article in the *"World's Work,"* Henry Ford writing of standardization says: "I don't care what the commodity is, if it is something that has a wide enough possible market it can pay high wages and give short hours and still sell the best quality of goods at the lowest possible price if its production is properly organized. The whole secret is to make one thing in one plant, concentrate every effort on that one standardized product, and adapt the machinery for its manufacture to automatic operation at the highest practicable speed. By 'educating' the machine instead of the worker, it is possible to use untrained or practically untrained labor and pay it high wages, and still perform mechanical operations that formerly baffled even the most highly skilled worker."

Railway Equipment Manufacturers' Association

At the annual meeting of the above mentioned association, held during the Traveling Engineers' Convention, $100 was contributed to the Tobacco Fund and $200 to Red Cross. The following officers were elected for the ensuing year: President, Gilbert E. Ryder, Locomotive Superheater Company; vice-president, C. W. Floyd Coffin, Franklin Railway Supply Company; secretary, D. L. Eubank, Galena Signal Oil Company; treasurer, B. C. Hooper, American Steel Foundries; executive committee members for three years, C. L. Brown, Manning, Maxwell & Moore; Morris Brewster, United States Metallic Packing Company, and F. W. Venton, Crane Company.

Double Tracking the Southern Railway.

The last link in the double tracking of the Southern railway between Washington, D. C., and Atlanta, Ga., is now nearly completed. The section between Central, S. C., and Cornelia, Ga., extending to sixty miles, will be completed when the section between Toccoa, Ga., and Ayersville, Ga., is finished.

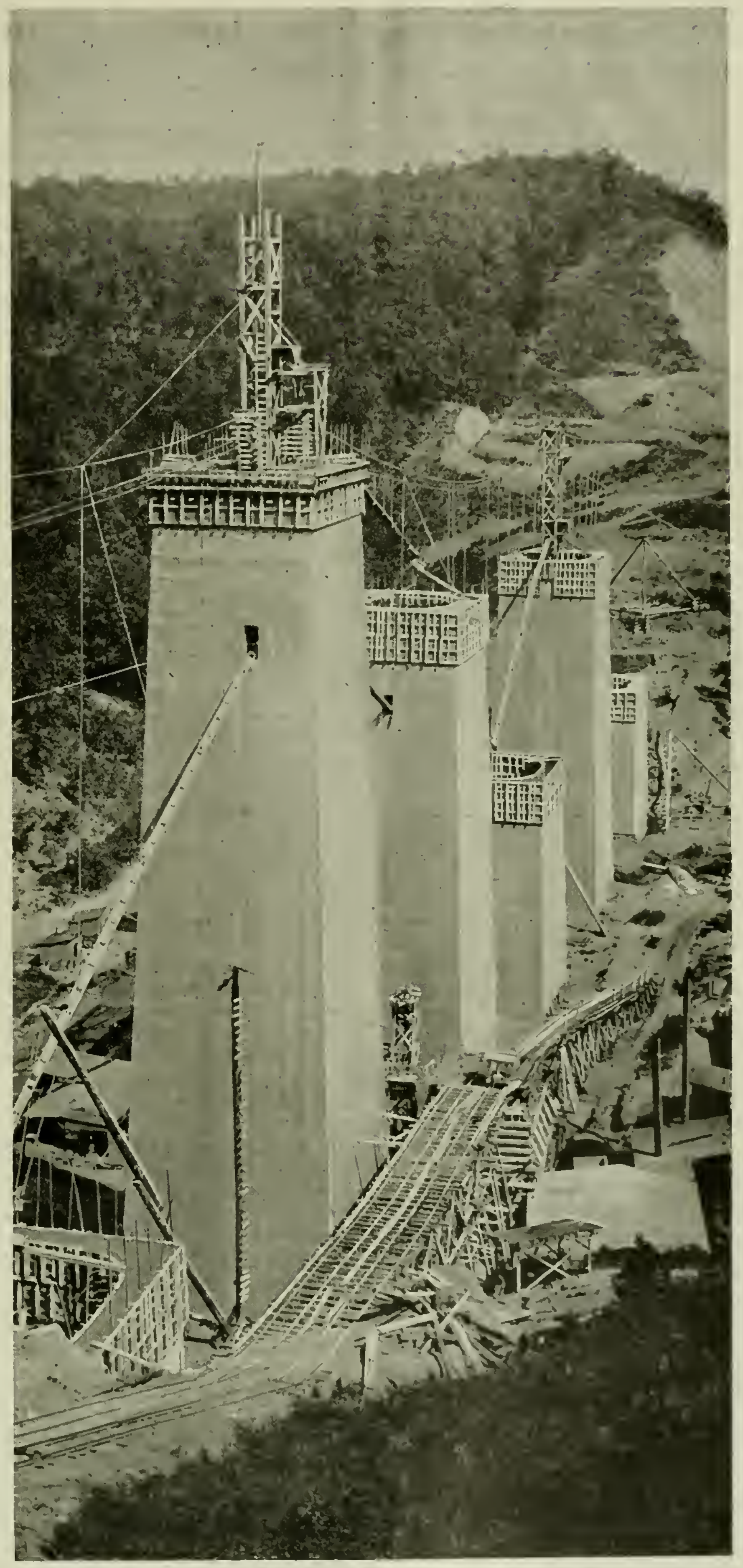
This section is the heaviest piece of work ever undertaken by the Southern Railway Company. It reduces the mileage from 7.6 to 6.0 miles. The maximum curve on the old line is nine degrees, and the maximum grade is 1.3 per cent while on the new line the maximum grade is 1.00 per cent and the maximum curve is 3 per cent. In this section there were to be two steel viaducts, one at North Broad River 1,600 ft. long and 210 ft. high, and one at Coldazell Creek, 2,800 ft. long and 160 ft. high. The lack of structural steel compelled a change in the original plans, and it was decided to fill over Coldazell Creek requiring about 1,800,000 cubic yards.

At the North Broad River it was decided to build hollow concrete piers with 100-foot steel deckplate girder spans between piers, and a 26-foot steel girder spanning the top of the piers. This change in plans called for about 45,000 cubic yards of concrete. There are eight hollow piers about 200 ft. in height. These are 30 by 34 ft. at the top. The hollow inside is circular. One mile south of Ayersville, Ga., is the last cut on the section. This cut contained about 300,000 cubic yards, most of which was unusually hard rock, and would have been found to be very difficult to remove but for the use of the very high-grade explosives.

The concrete work, already referred to, for the viaduct 1,400 feet long and 200 feet high, which is built with hollow concrete piers, gives the engineers of the Southern Railway Company the credit for having worked out the first hollow pier construction to be used for such a high bridge. The work was prosecuted under the general direction of Mr. R. O. Parsons, District Engineer, Southern Railway, Toccoa, Ga., but under the direct supervision of Mr. B. L. Grenshaw, assistant engineer for the Southern Railway, from Knoxville, Tenn.

Casing-Head Gasoline.

Casing-head gasoline is gasoline which passes off in the form of vapor with natural gas accompanying the flow of an oil well, where oil and gas are found in the same field. In many localities this gas is wasted because of the difficulty of handling it, or because no market exists for its sale, due to its relatively small volume. Often, however, the recoverable gasoline in the gas is worth as much as 20 per cent of the oil produced. Special cars are built for the transportation of Casing-Head gasoline.



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A Common Sense Scheme.

There is more than mere interest to us as railway men in what follows. If viewed in a certain light it contains a message and a lesson for us all.

The British Government has decided to promote the building after the war of some 300,000 workers' cottages as part of the scheme of national reconstruction. An important part of the planning for this great scheme is being done by women. This Women's Building Committee of the Reconstruction Ministry is seeing what can be done to assure that the houses of the future are so built as to be more in keeping with a woman's idea than with a man's of what a house should be.

The outward planning of the house they may leave safely to the men architects, so far as æsthetic beauty is concerned. Interiors are their strong point. They consider such things as the fireplace in relation to the coal hole. What are the clothes washing arrangements and the bathing arrangements?

With a view of saving labor for the housewife the committee goes closely into the provision of fitted-in furniture and other fixtures. Is there a suitable store place for food and is it on the south side of the house where the sun can get at it all day, or on the cold north side, where it should be?

The important part, and the striking feature of this whole plan is that it puts to practical application, a theory which is right and proper and which has for some reason been kept in abeyance, not only as far as housing of working people is concerned, but in other lines of endeavor. The common sense of the scheme is that the class of people who use, or live in, and work with what they have been given, will have a voice as to how things are to be made.

Many roundhouses on railways are planned and built by one department and occupied and lived in by another. The latter department during construction was not asked for so much as a suggestion as to the position of permanent appliances, or whether the work to be done could be done expeditiously or the reverse with the cut-and-dried layout that mechanical men are given and expected to successfully tackle. On a few railroads, once in a while, enginemen were asked for an expression of opinion as to the position of fittings and fixings in the cabs. The prevailing idea, however, even with these stray exceptions, as to the building and construction of things mechanical, was that they were no business of the mechanical department.

How far away, or how much difference in essence is this theory of expecting men to live how and where others tell them to, than that principle which all cry out against, that of subjecting a nation to a life it did not choose and cannot alter? Mechanical men were given arbitrary conditions to live under and work in, and in the last analysis and coming down to bed rock, wherein do some conceptions of national life in Europe differ from what we do on railways?

To work out the common sense plan as far as may be, where the old regime has previously been in vogue and is still extant, is to tell the people all that can be told them about the work they have to do. Electrical periodicals, air brake information is supplied by school cars, etc. Locomotive operation and fuel burning are subjects which are now taught and explained in various ways. In the matter of special appliances and accessories for locomotives, this dissemination of information has not been followed up by manufacturers as it might have been, and as it may be yet.

A new idea in advertising might be made to fill this very want, and copy might be written, not merely to catch the eye of the president or purchasing agent, (of which there are comparatively few) and who simply buy, but it might be so arranged that the man who works with, lives with, and makes his livelihood from repairing or working an appliance, shall constantly be kept informed as to the state of the art, the troubles he must look for, and what he should do.

The theory embodied in the department of reconstruction in Great Britain is capable of a wide application and can easily be made to include some phases of our railway work. New "locomotive homes" can be built, where those who know what they want will have some say. Even if old plants and structures have to be still used, the men in them can be more fully informed concerning the workability of new appliances. There is no doubt that this is the day for new ideas and new plans and the possible extension of this British idea to our own railway present-day, needs may be the means of finding a more successful adapter to particular cases in this country, than we would care to claim for ourselves.

Why Heat Feed Water?

In olden days when cotton factories were comparatively new, they were always shadowed by a loss, which of course fluctuated at times, but was never wholly absent. This was nothing more or less than the tangling of the yarn. If a thread broke, or if it gummed itself momentarily to a revolving spindle, a little loose ball of tangled thread was the result. This had to be pulled off the spindle by the worker and thrown on the floor for the watchman to gather up. This tangled ball of yarn represented a loss. It used up thread, restricted the output of the machine, and required a man to constantly gather it up. When he gathered it up, it could not be unravelled and was no good to anyone. It was, as its name implied "waste," pure and simple.

A factory producing "waste," could not be operated at its full value. The loss in the shape of waste was always present, and there was no way of obviating the trouble, it was a settled loss, it was waste. By-and-bye someone discovered that this lost and waste production of the factory, had a value. It was good for wiping up oil and cleaning things, and it was good for a host of other uses, and people asked the factory for it and the factory gladly gave it away, until the officers of the factory found that the "waste" had a commercial value under a steady demand, and then the factory sold it, and all the output of the mill, both dry goods and "waste," became productive and the formerly no good "waste" was called a by-product in the manufacture of cotton.

This little bit of history may help to throw some light on the operation of a locomotive, as it is today. The engine is intended to move itself, and to haul cars. That is its "output," measured on the scale of the cotton mill. In the gaining of this output the engine must burn coal to boil water. In order to boil water and generate steam fast enough, it supplies too much hot gas, and this hot gas goes through the flues and smoke-stack too quickly to do all the good it might do. The steam generated is full of heat and

not all of it is used. In early days this heat was let escape anyhow and nobody thought of calling it by so dignified and scientific name as a by-product. It was waste and represented a loss. And here let it be stated that a waste of any kind cannot become a by-product until it acquires a use which gives it a financial standing in the community, and so the people dealing with the early locomotives were right when they regarded the escaping hot gases and steam as a loss of heat pure and simple.

We have not made much progress in this line since early days. Anyone who stands on a railway crossing bridge on some highway, and feels the hot blast of steam and gas that is shot out of the stack, as the engine passes underneath, does not need to be told of the analogy between the cotton waste at the mill, and the wasted heat from the steam and smoke of the engine. In boiling the water heat is taken up by it in large quantities and the water is turned into hot steam. It is said on good authority that 76.7 per cent of the heat in any given quantity of coal properly burnt, goes into the boiler-water and that 65.2 per cent is carried away as a waste product from the exhaust and up the stack. This means that out of 100 units of heat, only 11.5 parts is made to do any useful work. The cotton mill was vastly better off because its "waste" at its very worst, was far less than the paying output. In the locomotive the whole thing is reversed and the loss exceeds the gain more than eight times. Add to this, the heat loss of the smoke box gases, and you have a condition which would make a cotton manufacturer go into bankruptcy.

The exhaust steam, with all its heat, is at present only used to stimulate the draught on the fire, and to that extent it is good, but the heat lost in this process is yet so heavy that the waste heat has not been elevated by use to the status of a legitimate by-product.

One of the best and surest ways to make this waste heat into a useful by-product is to apply it to heating the feed water of an engine. Applications now in service on several railroads give promise of a satisfactory solution of locomotive feed water heating. In the meantime it is the duty of master mechanics, traveling engineers, enginemen and firemen, and all the minor officials having to do with locomotive operation, to study the whole problem so that they will not have to hunt around for information when it is urgently needed. They should know the theory of it, what it aims to do, and how it does it, before they have to work with it, and live with it, and "make it go." When a thunderstorm is in progress it is no time to begin to look for a lightning rod. It ought to be there and ready for the stroke, before it comes.

The need for some appliance to heat the water which goes into the boiler, by means of some of the heat which goes into the steam in the process of boiling (and which comes out again as a loss), is the true, scientific method of dealing with the problem. It makes part of this waste heat do some useful work. It gives it the standing of a by-product, by letting it have a chance to save coal, and that saving has been estimated as 10 per cent of the coal thrown into the firebox. This is an extremely important consideration, now more than ever, and foreknowledge of the whole process is at this day open to the rank and file of railway men and they should study it, because come it must, in these days of thought and action.

The waste we have spoken of is Dame Nature's way of working. As pointed out in a recent article by Prof. I. W. Howerth of the University of California in the *Scientific Monthly*, "To appreciate the waste of Nature, one has but to compare its potential, with its actual achievement * * *," and he quotes Asa Gray as saying, "The waste of being (he means life), is enormous, far beyond the common apprehension, * * *. As of the light of the sun, sent forth in all directions, only a minute portion is intercepted by the earth or other planets, where some of it may be utilized for present or future life, * * *."

In the course of his reasoning, Prof. Howerth makes out that Nature is wasteful, slow and uncertain. For mankind to appropriate to his own uses, the potentialities of Nature, they must be modified by the purposive, intelligent will of man. This is an incentive to action, and a glimpse of man's duty. It is not merely theorizing about duty, to say that it applies to the making of good, better. It deals, in its widest sense, with intelligent action which has for its righteous aim the elimination of waste in all the forms, that Nature shows us, abound everywhere. It is not by damming of the current, but by cutting new channels that we may be benefited. The saving of the waste heat in a locomotive by the method we have mentioned is one of the best channels in the making of which, we may properly look for an adequate return, and the full mental appreciation of this whole matter, can only do us good and make us ready, and widen our views, and subsequently our action, in successful railroad operation.

Traffic Moving in Waves.

We are accustomed, by the use of terms connected with the war, to refer to companies or regiments following one another in a continuous series of "waves," as they go over the top. The word "waves," signifying groups or units of men, has become quite familiar to readers of the war news. We have had, chiefly owing to the influenza epidemic and the war, a home application of the idea of human waves, and it has been applied to the handling of traffic in the cities and the larger towns, during the rush hours.

The daylight-saving idea has nothing to do with the advantages of dividing the starting, and the home-coming, traffic into waves. In the daylight-saving scheme only the hands of the clock were moved. People who rise at 7 A. M. go on with their daily work, no matter where the clock hands have been officially placed with reference to the sun. A certain time is called five o'clock in the morning, winter or summer, and all recognize it as such, and the same sequence of household, domestic or civic events go on as usual, and are carried out by all the people together. Crowding and crushing, as far as traffic is concerned, is not altered.

Years ago, Sir Sandford Flemming, who built the Inter-Colonial Railway in Canada, evolved a plan for producing what he called universal time. His idea was to have 12 o'clock noon in London the starting point for the whole development. Workmen in London would go to dinner at noon, but in Canada, being five hours slower, the workman would eat his mid-day meal at what was to be called 5 P. M., though the sun was then at the meridian. The object was to make the same date and time apply to the whole world, so that 2 P. M. on Sunday 3rd November would mean one, and only one thing wherever time was reckoned. This plan, however, did not seek to break up or disarrange community life in any place. Crowding at "rush hours" would remain the same under Sir Sandford's plan as it had previously existed.

The idea involved in "waves of traffic," does not alter the clock, but alters the actions of people. Office hours are nominally from 9 A. M. to 5 P. M., with an hour for lunch. That is 7 working hours a day. If one begins at 8 A. M. and stops at 4 P. M., an equal number of hours has been consumed in business. The same holds good for a later start and a later shut down, and it holds goods for all intervening fractions of hours. If section A, of a city, opens and closes on the even hours, and section B does similarly, only with a quarter of an hour later start, and close, and section C, similarly, but on the even half-hour, and section D, on the three-quarters past, and E again on the even hours, but one hour later than A: we would have five successively released "waves" of humanity, moving north or south, let us say, and the transportation system handling the "wave traffic," would have the time to do it in, lengthened about equal to that in which the waves were released, and the peak of the load would appear flatter and longer.

This alteration shown on the time-and-power curve of an electric system, would

mean less crowding of the passengers, a more expeditious and a safer handling of the trains, and a less intensive expenditure of power for a short time, by the company. Both public and company would reap benefits, which would be satisfactory to each. The company could make fewer cars perform the work as the time of maximum exertion being lengthened, some cars might be returned for a second trip before the last "wave" appeared, and probably electric equipment if speeded up, would be able to cope with the increased traffic, without as now, calling in an extra and hitherto idle electric generator service. The traveling public would be more comfortable, as better accommodation could be provided, and with the lengthening of headway time, without impairing the service, greater security and greater safety could be had in handling trains on the "wave traffic" system.

There has hitherto been much bitter feeling indulged in by the public toward the transportation companies, much of which has been amply justified, but the war has shown us the immense advantages of intelligent co-operation, and here, certainly, is one of the things where public and company can co-operate with mutual benefit and profit, and the inestimable boon of an appreciable approach to safe travel, can be satisfactorily brought about.

New Car Conditions to Be Met.

It has been insisted upon by those in a position to know, that if shippers of car load lots used the same care in their loading that the railroads and terminal officials use in loading less than car loads of freight, the alleged shortage of rolling stock would disappear. The waste of car space is less than it was, but is still very great according to Mr. E. Durand, writing in the *Bush Magazine*. Last spring the P. R. R. showed that if the then wasted space were properly utilized on its own system alone, it would be equivalent to adding about 120,000 cars to its equipment. Reinforcing this state of affairs, the railways did increase the car supply by about 114,000 cars by means of intelligent loading.

Mr. Durand goes on to say: The chief cause of under-loading is the so-called "trade units." These units were originally established upon the basis of the minimum car capacity fixed in the tariffs of the carriers. Thus the trade unit for oil in barrels is 65 bbls., weighing 26,650 lbs. The maximum capacity of a 40-ft. car, however, is 148 bbls., weighing 60,680 lbs. So it will be seen that more than twice as many cars as necessary may be employed in transporting oil in barrels.

The same fundamental evil obtains in many trades. The normal "carload" of fertilizer in bags, for example, is 250, weighing 42,000 lbs., whereas a car of 100,000 lbs. capacity will accommodate 600 bags. The normal trade unit carload of sugar is 400 bags, whereas 1,000 bags can be shipped in a single car. When shipped in barrels the trade unit is generally 100 bbls., weighing 37,820 lbs., whereas 244 bbls. weighing 90,960 lbs. can be accommodated.

Shippers who complain that they cannot get cars and buyers who rave because they cannot have deliveries are themselves largely to blame. By continuing to abide by trade customs which result in underloading cars they tie up railroad equipment and in many instances demand twice as many cars as are necessary to move their commodity.

But the railroads can and do control the amount packed in L. C. L. cars made up at terminals from the mixed freight offered by small shippers.

During the year ending last July the seventy-seven railroads from which reports were received handled 579,180 cars of L. C. L. freight. During the year ending July, 1916, the average loading was 11,619 lbs.; this year it was 13,927 lbs., or an increase of almost 20 per cent. If the old method of underloading had been followed, it would have required 693,289 cars to move this freight instead of 579,180 cars, a saving (with expeditious repairs) of 114,109 cars, practically given to the railways.

For the most part, this underloading is the result of habit, ignorance or carelessness. The buyer orders a "carload" of this or that, specifying the number of bags, barrels or bales. This number is the general trade unit for a carload and was established probably years ago when cars were smaller and when railroads, eager for business, set the minimum both for number of pieces and for weight as low as possible. The emergency of war calls for an immediate revision of these standards. The buyer should inform himself on what actually constitutes a carload and place his orders accordingly. Where conditions prevent his buying in full car lots he might, with advantage to all concerned, club his purchases with other buyers so as to insure the hauling of full cars. In this the shipper can co-operate by intelligent combining of orders.

Government boards are now taking a hand in solving this problem, but their activities should be anticipated by shippers eager to "do their bit." Every purchaser and seller should feel his individual responsibility in the crisis and should take the initiative as applied to his business.

Honoring Locomotive Engineers

On some railroads the practice of painting the names of engineers on the cabs of locomotives, signifying that the recipient of this distinguishing mark had a long and flawless record, seems to be growing in popular favor. Some years ago it came prominently into practice on the Erie by naming the first Mallet compound Angus Sinclair, our editor-in-chief and dean of the apprenticeship system on the Erie. The first triplex compound was named for Matt Shay of the same road. Recently General Superintendent J. J. Mantell, of the Erie, had two of the company's engineers' names painted on the cabs of the locomotives they have been driving, "for long service, strict attention to duty, and loyalty." They are Sydney Luckey and Charles Watts. Mr. Luckey, of the Delaware division, has nearly finished forty-nine years of service, and Mr. Watts, of the Buffalo division, forty-three years.

Long service coupled with a good record and unquestioned loyalty to the company served—which also would mean loyalty to the public and to a personal conception of duty—could not be more fittingly recognized than by having the name of the deserving engineman painted on the cab of his engine. And the fact that he might not at all times run the same engine would not in the slightest diminish the honor conferred. His name would be where every one might see it, and seeing it would spur other enginemen to follow the example thus appropriately emphasized.

That the practice appeals to the managing officials of other systems is evidenced by the action of the Canadian Pacific Railway in deciding recently on what the management calls a "new policy." Certain of the company's more than two thousand locomotives are being named after enginemen, who by meritorious conduct or by acts of special bravery, in the opinion of the management, have earned the right to special distinction.

The names are incorporated in the newly adopted insignia of the railway—a circular band enclosing a beaver placed on a shield on which is painted the Maple Leaf—Canada's emblem. The name of the engineman is in letters of gold upon a blue ground, which, with the green leaf, the white shield and the brown beaver, make a color combination peculiarly striking and effective. This insignia is painted under the windows of the engine cab, the most conspicuous and at the same time most appropriate position that could have been selected.

More than fifty locomotives in the passenger service of the Canadian Pacific now bear the names of enginemen. The Canadian Pacific management says regarding this new policy: "The idea is one which should appeal to every man who knows the value of personality in good railroading. It appeals to the C. P. R. because it will make for efficiency and encourage that *esprit de corps* which is the keynote of the whole Canadian Pacific System."

Air Brake Department

Differences Between PM Brake Equipment, High Speed Brake With Type L Triple Valve and LN Equipment—Supplementary Reservoirs Should Be Used in Connection With Type L Triple Valves

Certain questions have been raised in reference to the use of supplementary reservoirs, when cars are equipped with them, it being the practice on some roads to operate type L triple valves with the supplementary reservoirs cut out. In some instances it is said that cutting them in is undesirable and that air brake troubles are encountered through attempting to operate LN equipment in mixed trains, and an explanation of the differences between these equipments has been requested.

The quick action automatic brake consists primarily of a brake cylinder for utilizing the power of compressed air and transmitting it through suitably arranged foundation brake gear to become effective in bringing the shoes in contact with the tread of the wheels, an auxiliary reservoir proportioned to the size of the brake cylinder employed and used to store a volume of compressed air for the operation of the brake piston of the brake cylinder, and a triple valve known as the type P, which consists mainly of a piston and slide valve encased in suitable bushings and which is operated through a differential in pressure obtained between the brake pipe and the auxiliary reservoir. The auxiliary reservoir is charged through the triple valve from the brake pipe pressure when the triple valve is in release position, and at this time the brake cylinder is open to the atmosphere through the triple valve slide valve. When a brake application is desired, the brake pipe pressure is reduced at a faster rate than at which it can flow back from the auxiliary reservoir through the triple valve feed groove into the brake pipe, and this results in the differential in pressure that causes the movement of the triple valve parts to admit air pressure from the auxiliary reservoir into the brake cylinder, applying the brake, the movement of the parts to application having severed communication between the brake cylinder and the atmosphere. When a release of brakes is desired, the brake pipe pressure is increased above that remaining in the auxiliary reservoir, or the auxiliary reservoir pressure may be reduced below that remaining in the brake pipe, and any such difference thus obtained moves the triple valve parts to release position, opening the brake cylinder to the atmosphere for a release of brakes and recharging the auxiliary reservoir.

The triple valve also contains a series of supplemental valves, which are operated by a sudden reduction of brake pipe pressure or when the rate of brake pipe reduction exceeds the capacity of the service port of the triple valve to expand auxiliary reservoir pressure into the brake cylinder. This causes the triple valve parts to travel their full stroke, opening the brake pipe to the brake cylinder for the continuation of the brake pipe reduction rate, or the initiation and propagation of quick action throughout the train, the intent being that the brakes on a train may become fully applied throughout in advance of any otherwise violent change of slack in the train.

To change from the quick action brake to the high speed or what is commonly known as the PM equipment, it is only necessary to increase the brake pipe pressure to 110 pounds, and add a high speed reducing valve to the brake cylinder, to limit the service braking ratio of the car to a predetermined figure. This valve also reduces the initial emergency braking ratio in a limited space of time.

The type P triple valve may be changed for one of the type L design, which is then generally known as the high-speed brake with type L triple valves; this valve contains all of the features of the P triple valve and in addition a quick service and quick recharge of the auxiliary reservoir.

If desired, a supplementary reservoir may be added to the type L triple valve, and the high-speed reducing valve removed from the brake cylinder, and the brake equipment will then be what is known as the LN, having all of the features of the high-speed brake and in addition a quick service, quick recharge of the auxiliary reservoir, high emergency brake cylinder pressure, graduated release and a safety valve feature. Commenting on these features separately:

Quick Service.—When the triple valve piston and slide valve are moved to application position, for an application of the brakes, an opening of a fixed size is made from the brake pipe to the brake cylinder, making a local brake pipe reduction at each triple valve, thus hastening the time of serial brake action throughout a train of cars, or a certain per cent of the brake pipe volume is reduced at the triple valves which would otherwise escape at the brake valve of the locomotive or at some other brake pipe opening, necessarily involving a greater element of time for the same amount of brake pipe reduction to take place. There is an unavoidable difference in time in the application of the brake on the first and last cars in a train, during service operation, and this serial hastening of the brake pipe reduction and consequently the application of the rear brakes of the train, materially assists in reducing the velocity differences between the various cars of a train, the velocity differences or differences in speed between cars of a train being the cause of shocks in trains during brake applications resulting in what is frequently termed "rough handling," and results in damage to equipment and slid flat wheels, through the fact that the change in speed through shock suddenly accelerates certain cars in a train to a greater speed than the wheel can instantly increase in speed with the brake shoe applied, with the result that the adhesion between the wheel and rail is broken and the wheel slides. The damage to equipment through shocks during brake applications cannot be disregarded when it is known an elaborate series of scientific tests have demonstrated that when the difference in speed between two cars is only one mile per hour, the impact or blow resulting is approximately equal to the weight of one car, both weights being equal, or where one car is lighter than the other the force of the impact is equal in proportion to the weight of the lighter car to that of the heavier in per cent. With trains of ten cars and both front and rear portions solidly bunched (slack out of couplings) an impact or blow of 400,000 pounds has been obtained through the influence of unequal braking effect, or through velocity differences produced by differences in time of serial brake action, hence the importance of a quick service feature which tends to minimize the shocks which are frequently of such violence that only the capacity of the draft gear to absorb shocks prevents the breaking of couplings. This is recognized to such an extent that where traffic conditions are exceedingly heavy the air brake is operated by electric current (and certain railroads are equipping steam road trains with electro-pneumatic brakes) for the express purpose of eliminating the time element incident to serial action of brakes.

Quick Recharge.—The quick recharge

of the auxiliary reservoir is obtained from the supplementary reservoir, which has a stored volume of 2½ times that of the auxiliary reservoir, these sizes varying with the size of the brake cylinder. In this manner the auxiliary reservoir is recharged for subsequent brake applications at approximately the same rate that the brake pipe pressure can be increased from the main reservoir of the locomotive, the first consideration having been to provide for repeated applications of the brakes without materially depleting the braking force, or through which four or five full service applications of the brake may be made without any recharge of the system from the locomotive, and if an emergency should arise a braking force equal to that employed with the high speed brake with full pressure could still be obtained. The result that has been incidentally obtained is that as the auxiliary reservoirs are recharged from the supplementary reservoirs there is no drain on the brake pipe during a release of brakes, that is, some auxiliary reservoirs are not absorbing brake pipe pressure from the head end of the train at a rate that is in excess of the capacity of the air compressor before the rear brakes have reecived an increase of brake pipe pressure necessary to produce a movement of the triple valve parts to release position. This resulting in the failure of brakes to release and the consequent sliding of wheels, to say nothing of the rough handling through trying to start a train with some of the brakes applied.

(To be continued.)

QUESTIONS AND ANSWERS

Locomotive Air Brake Inspection.

(Continued from page 356, Nov., 1918)

567. Q.—Why does the low pressure piston not work against a higher pressure than 40 lbs. when the compressor is in good condition?

A.—The air is only delivered to the high pressure cylinder during the first stage of compression.

568. Q.—Where is it delivered from the high pressure cylinder?

A.—To the main reservoir.

569. Q.—Which is the type of compressor of next highest efficiency?

A.—The duplex type.

570. Q.—Why so?

A.—Because it also compresses air in two stages.

571. Q.—As to percentage of efficiency under average conditions of service, what per cent. of a cylinder full of free air does a 9½ ins. pump deliver on each stroke of the piston?

A.—About 60 per cent.

572. Q.—The 11 ins. pump?

A.—About 68 per cent.

573. Q.—The duplex types of compressors?

A.—About 76 per cent.

574. Q.—The cross compound compressor?

A.—About 87 per cent.

575. Q.—Why has the 11 ins. pump a higher per cent. of efficiency than the 9½ ins. pump, both being single stage compressors.

A.—Principally on account of the 11 ins. pump having a 12 ins. stroke and the 9½ ins. having but a 10 ins. stroke.

576. Q.—Is the higher air delivery efficiency of the compound compressor the only reason for its general adoption for railroad service?

A.—No; it also shows a 50 per cent. or more saving in coal consumption for a given amount of air compressed, over that of the single stage compressors.

577. Q.—Is there any distinction between the terms "single stage" and "single acting" as applied to 9½ ins. and 11 ins. pumps?

A.—Yes, the term "single acting" is usually applied to pumps that deliver a cylinder full of air on each cycle, a complete revolution, or two strokes, such as compressors used in electric service.

578. Q.—The 9½ ins, and 11 ins. pumps are then termed as what?

A.—"Double acting" but "single stage" pumps as the air is delivered from the same cylinder in which it is compressed in its first stage.

579. Q.—Why does the cross compound compressor show the remarkable saving in coal consumption on an equal air delivery?

A.—Because the steam cylinders are compounded, and only a high pressure steam cylinder full of steam is used on each stroke, the exhaust steam from the high pressure cylinder performs the work in the low pressure steam cylinder.

580. Q.—How is this steam cylinder efficiency determined?

A.—By noting the number of pounds of steam consumed by each type of compressor per hundred cu. ft. of free air compressed and making a comparison.

581. Q.—What is meant by a pound of steam?

A.—An amount of steam that when condensed composes one pound of water.

582. Q.—How much coal does it take to evaporate one pound of water?

A.—It varies with the grade of coal, but it is generally assumed that one pound of coal will evaporate seven pounds of water.

583. Q.—With the average boiler pressures carried on locomotives, and the compressors working against 110 lbs. air pressure, about how many pounds of steam is required to compress 100 cu. ft. of free air with an 11 ins. pump?

A.—About 60 lbs. per hundred cu. ft. of air.

584. Q.—About how much steam with the cross compound compressor under the same condition?

A.—About 25 lbs.

585. Q.—Does exhaust steam alone operate the low pressure steam and high pressure air pistons of the compound compressor?

A.—No, these pistons are assisted by compressed air from the low pressure air cylinder.

586. Q.—Is live steam used in the low pressure cylinder at any time?

A.—Not unless there is some leakage past the high pressure piston packing rings or through the steam cylinder gaskets.

587. Q.—Why is a single stage compressor so wasteful in the use of steam and consequently waste of fuel?

A.—Because there is no point of cut off. In steam distribution, as in a locomotive valve gear, there is a cut-off point, but by a compressor a measure of steam is required to compress an equal amount of free air. Live steam is compressed for the entire stroke of the piston and the highest steam cylinder pressure is obtained at the extreme end of the stroke.

588. Q.—Why is the highest steam pressure reached at the end of the stroke?

A.—Because the air pressure reaches its maximum at the end of the stroke.

589. Q.—How does the distance of the piston stroke vary in the single stage pumps?

A.—At a low air pressure, the piston travels practically the entire stroke, through the cylinder, but at a higher pressure it does not travel quite so far.

590. Q.—Why is this?

A.—The piston movement near the end of the stroke reduces in speed with an increase in the pressure the piston is working against, this permitting more time for the steam valve mechanism to operate and reverse the movement of the piston.

591. Q.—And the result?

A.—The piston movement is reversed a trifle further away from the end of its stroke, changing the length or distance of the piston movement.

592. Q.—How is the air compressor tested for efficiency?

A.—By working it at a specified rate of speed against an opening to the atmosphere of a fixed size and noting the air pressure that is maintained.

593. Q.—What size of opening is used for the 8½ ins. compressor as specified by the Federal Regulations?

A.—9-32 of an inch.

594. Q.—What is the rate of speed for the test?

A.—100 single strokes of the low pressure air piston per minute.

595. Q.—What air pressure is to be maintained?

A.—60 lbs.

596. Q.—What is the size of the opening to test the 11 ins. compressor?

A.—3-16 of an inch.

597. Q.—What rate of speed should it be run?

A.—100 single strokes per minute.

598. Q.—What pressure should be maintained?

A.—60 lbs.

599. Q.—What is the rate of speed, size of opening, and pressure to be maintained for testing the 9½ ins. compressor?

A.—11-64, opening, 120 single strokes per minute, pressure to be maintained at 60 lbs.

600. Q.—What are these same figures for the N. Y. 5-B compressor?

A.—100 strokes, 15-64 opening, 60 lbs. pressure.

601. Q.—For the N. Y. 6-A?

A.—100 strokes, 13-64 opening, 60 lbs. pressure.

602. Q.—What other expression is sometime used to express 120 single strokes?

A.—60 cycles.

603. Q.—What if these compressors do not maintain the air pressure against the specified size of opening, or if a faster speed is required to maintain this pressure?

A.—The compressor is unfit for further service.

604. Q.—Is it a violation of the law to run a compressor in this condition?

A.—Yes.

605. Q.—Can these rates of speed for test be changed under any particular condition without violating the regulations?

A.—Yes, for altitudes over 1,000 ft.

606. Q.—Explain how the number of the strokes can be increased per minute to compensate for lower atmospheric pressure at higher altitudes?

A.—For altitudes over 1,000 ft. above the sea level the speed may be increased 5 single strokes per minute, and 5 additional strokes for each increase of 1,000 ft. in altitude, all other requirements of the test remaining the same.

(To be continued.)

Train Handling

(Continued from page 357, Nov., 1918)

589. Q.—What bad results are obtained from using an excessive amount of oil in the air cylinders?

A.—The valves, ports and passages are gummed up causing the compressor to run hot and very materially reduce its efficiency.

590. Q.—Any other bad effect with the large capacity compressors?

A.—It causes the intermediate air valves to stick open and cause engine failures, through failure of the compressor to maintain the required air pressure.

591. Q.—What effect has the sticking of valves on the compressor bracket studs?

A.—The heavy pound resulting causes the bracket to loosen and break off studs in the boiler.

592. Q.—How should air cylinders be lubricated when they have oil pipes attached to the locomotive lubricators?

A.—With 8 or 10 drops per cylinder when the compressor is started, and then the feed should be closed off tightly.

593. Q.—Should the air cylinders not be fed continuously?

A.—Under no circumstances, they should not be oiled again until the end of the trip unless they start groaning.

594. Q.—Should they be lubricated at the end of the trip?

A.—Yes, before the engine goes on the fire track, each cylinder should be given 8 or 10 drops both steam and air.

595. Q.—What is the object?

A.—To have the cylinders well lubricated before the fire is being cleaned, as the compressors will be run for a considerable length of time without receiving any lubrication whatever.

596. Q.—Should a compressor be run on the fire track?

A.—Not if it can be avoided.

597. Q.—Why not?

A.—Because ashes and cinders will be drawn into the cylinders, clogging the air strainers and cutting the cylinders.

598. Q.—Why are they generally permitted to be run on the fire track?

A.—To avoid the lesser of two evils, someone might forget to re-open the throttle and have an accident.

599. Q.—What bad results are encountered from running a compressor at too high a rate of speed?

A.—It tends to cause overheating and consequently bad results in general.

600. Q.—How is the pump run when it is found to be excessively heated?

A.—The compressor is to be well oiled and the speed reduced to as low a figure as possible and still maintain the air pressure.

601. Q.—What bad effect has an overheated compressor on the rest of the brake equipment?

A.—The hot and burning oil will usually be scattered through the brake apparatus and result in defective operation of the pressure controllers and produce hard handling brake valves.

602. Q.—An overheated compressor can then be considered as what?

A.—About the most serious and annoying disorder of the entire brake equipment.

603. Q.—What is the recommended speed for air compressors?

A.—Not over 70 cycles or 140 single strokes per minute.

604 Q.—What other part of the compressor requires lubrication?

A.—The piston rods, where a well oiled swab should be maintained.

605. Q.—Of what particular oenefit is this?

A.—It prolongs the life of the rod packing, and if metallic packing is used a well oiled swab is absolutely necessary.

606. Q.—What part of the air compressor is it important to keep clean?

A.—The air strainers.

607. Q.—Should this be done by wiping them with waste?

A.—No; this only closes the holes in the strainers, they should be removed and either be cleaned in lye water or be blown out with a jet of steam.

608. Q.—What kind of a strainer should be used?

A.—One in which the air admitted to the cylinder must pass through curled hair, which will prevent dirt from entering and tend to keep the cylinders from being oiled through the strainers.

609. Q.—When should drain cocks in the steam cylinders be opened?

A.—When the throttle is shut off in the engine house or storage yard.

610. Q.—What causes compressors to make a short stroke?

A.—Defects of the reversing valves or valve rods.

611. Q.—What when they work with uneven strokes?

A.—Defects of the air valves or air piston packing rings.

612. Q.—What causes a blow back at the air strainers?

A.—Leaky receiving valves.

613. Q.—What causes a constant inrush at the receiving valves or air strainers of the single stage compressors?

A.—Partly closed air strainers.

614. Q.—What causes a poor suction at the air strainers?

A.—Usually leaky air piston packing rings or badly leaking discharge valves.

615. Q.—What operates the steam valve of a pump governor?

A.—The governor piston.

616. Q.—And the piston is operated by what?

A.—Main reservoir pressure.

617. Q.—Where should air pressure be discharging while the governor is in control of the compressor?

A.—From the vent port through the casing below the diaphragms.

618. Q.—The effect of this port is stopped up?

A.—The governor will not be sensitive to regulate reservoir pressure.

619. Q.—What would be wrong if there was a waste of air at that point while the main reservoir pressure was considerably below the standard?

A.—It would be due to a leaky diaphragm valve.

620. Q.—What would be the effect of a stopped up waste pipe?

A.—The governor would not stop the compressor when the desired main reservoir pressure has been obtained.

621. Q.—The compressor delivers the air pressure direct to where?

A.—The main reservoir.

622. Q.—What other two reservoirs are found on engines equipped with the ET or LT brake?

A.—The distributing valve or control valve reservoir and the brake valve equalizing reservoir.

623. Q.—Where does main reservoir pressure end?

A.—At the rotary valve seat of the automatic brake valve, and the supply valve and regulating valve seats of the feed valve and reducing valves.

624. Q.—It also flows to?

A.—The application portion of the distributing valve, to the air gauge and the pump governor.

625. Q.—Where does brake pipe pressure begin?

A.—At the regulating and supply valves of the feed valve.

626. Q.—And ends where on its way to the distributing valve reservoir?

A.—At the pressure chamber feed groove.

627. Q.—What is the pressure surrounding the equalizing slide valve of the distributing valve termed?

A.—Pressure chamber pressure.

628. Q.—What is the independent brake valve used for?

A.—To operate the brakes on the locomotive alone.

629. Q.—What pressures do the different hands of the air gauges register?

A.—Large gauge, red hand main reservoir, black hand equalizing reservoir, small gauge, red hand brake cylinder, black hand brake pipe.

630. Q.—At what point in the brake pipe is the black hand tube of the small gauge connected?

A.—Below the brake valve cut out cock.

631. Q.—For what purpose?

A.—To indicate the brake pipe pressure at all times regardless as to whether the engine is the first or subsequent engine in double heading.

632. Q.—What is the correct air pressure to be carried in the brake pipe and brake cylinders?

A.—45 lbs. brake cylinder, 70 lbs. freight 110 passenger unless otherwise specified by special instructions.

(*To be continued*)

Car Brake Inspection.

(*Continued from page* 357, *Nov.*, 1918)

533. Q.—Is the broken graduating spring certain to cause undesired quick action?

A.—Practically nothing is positively certain in connection with this disorder. On a very short train it is likely to cause it, but on a long train the brake pipe reduction will be at a slower rate and the auxiliary reservoir pressure can reduce as fast as the brake pipe pressure reduces and there will be no work for the graduating spring to do.

534. Q.—How about a broken graduating pin?

A.—With the triple valve otherwise in good condition the broken graduating pin, while not permitting the graduating valve to open, will in a long train have no noticeable effect. The triple valve moving slowly will pass service position and expand auxiliary reservoir pressure into the brake cylinder through the port in the slide valve seat and past the emergency piston at as fast a rate as the brake pipe pressure is lowering and quick action will not occur, but on a short train it is very likely to cause undesired quick action.

535. Q.—What effect has an unusually short piston travel?

A.—If extremely short the auxiliary reservoir has insufficient space to expand into, and it may cause sufficient difference in pressure to move the triple valve to emergency position.

536. Q.—Is there anything else that may contribute?

A.—It may be contributed to by the difference in the expansion of metals under different temperatures, to moisture in the brake pipe, freezing of the moisture, or to the contraction of compressed air when it is delivered by an overheated air compressor.

537. Q.—Please explain manner in which undesired quick action results from a high temperature of the compressed air?

A.—When compressed air is heated it is expanded and shows what may be termed an unreal pressure or a pressure partly due to temperature, and as the temperature is lowered the compressed air instantly contracts with a resultant lowering of pressure. Therefore if a brake pipe reduction is started with the pressure under an abnormal temperature the sudden lowering or contraction may add to the reduction sufficiently to lower brake pipe pressure at a rate in excess of that permissible for service operation and quick action may be the result.

538. Q.—How much pressure in the brake cylinder is required to prevent a quick action or emergency application?

A.—After about 25 or 30 lbs. brake cylinder pressure is obtained quick action will not be transmitted and if the brake valve is placed in emergency full service operation only will occur.

538½. Q.—What is the principal difference between the freight and passenger car brake installation?

A.—The passenger triple valves are of a larger size and bolted to the pressure head of the brake cylinder, while on the freight car the triple valve, cast iron auxiliary reservoir and brake cylinder are usually bolted together.

539. Q.—Why is this arrangement on the freight car?

A.—To economize in the space to be taken up by the brake equipment.

540. Q.—Is this method of installation ever varied?

A.—Yes, sometimes the brake cylinder is detached from the auxiliary reservoir and triple valve.

541. Q.—What are these brakes termed?

A.—The combined and detached types.

542. Q.—How does air pressure pass from the triple valve through the auxiliary reservoir into the brake cylinder?

A.—Through a tube running through the reservoir.

543. Q.—What other valve is attached to the auxiliary reservoir?

A.—The release valve.

544. Q.—What valve is attached to the triple valve exhaust port?

A.—The retaining valve.

545. Q.—What is it used for?

A.—To retain a certain amount of air pressure in the brake cylinder while the triple valve is in relase position recharging the auxiliary reservoir.

546. Q.—When is the valve used?

A.—In descending heavy grades.

547. Q.—What indicates when the valve is, or is not, in operation?

A.—The position of the valve handle when vertical the retaining valve is not in operation, when at horizontal or at an angle of 45 degs. the valve is in operation.

548. Q.—How many types of valves are in general use?

A.—There are quite a number, but principally weight and spring pressure types, both single and double pressure.

549. Q.—What pressure does the single pressure type maintain in the brake cylinder?

A.—Usually 15 to 17 lbs.

550. Q.—And the double pressure valve?

A.—There are a variety, retaining 10-20, 15-30 and 25-50.

551. Q.—What generally governs the type of valve that is used?

A.—The capacity and light weight of the car.

552. Q.—Which is the high pressure position of a double pressure valve?

A.—Half way between horizontal and vertical.

553. Q.—Are retaining valves furnished for passenger cars?

A.—Yes, in almost as large a variety as for freight cars.

554. Q.—What type of valve is recommended for both freight and passenger cars?

A.—The spring type.

555. Q—Why?

A.—The spring is more accurate in seating the valve than the weight.

556. Q.—What improvement is there in this type of valve?

A.—Provision is made for attaching an air gauge for a brake cylinder and retaining valve pipe test.

557. Q.—What railroads use retaining valves on passenger cars?

A.—Usually those operating over very mountainous districts.

558. Q.—Are all freight cars equipped with retaining valves?

A.—All freight cars offered in interchange must be equipped with them.

559. Q.—What are the names of the air pipes on a freight car?

A.—Brake pipe and retaining valve pipe.

560. Q.—How many branches has the brake pipe?

A.—One, leading to the triple valve.

561. Q.—And with the detached type of brake?

A.—A brake cylinder pipe, leading from the auxiliary reservoir to the brake cylinder.

562. Q.—What does the branch to the triple valve contain?

A.—A stop cock and centrifugal dirt collecter.

563. Q.—What is the object of the cut out cock?

A.—To prevent air from passing to the triple valve when the brake is cut out.

564. Q.—What is the object of the dirt collecter?

A.—To collect dust or foreign matter that may be passing from the brake pipe toward the triple valve.

565. Q.—How does it collect the dirt?

A.—The air passing through it must move in a circular swirl and pass out at the top of the cock.

566. Q.—And this permits?

A.—The dust and other matter to collect at the bottom through centrifugal force and gravity.

567. Q.—How can it be told when the dirt collector is on backwards?

A.—An arrow cast on the body indicates the direction in which air should pass.

568. Q.—How is a dirt collector cleaned?

A.—By removing the plug at the bottom of the collector and emptying it and blowing it out with brake pipe air before replacing the plug.

569. Q.—How often should this be done?

A.—Every time the triple valve receives attention.

(To be continued)

A meeting of the New York R.R. Club was held November 15. The subject of "Fuel Conservation" was discussed by Eugene McAuliffe, manager fuel conservation section, United States Railroad Administration; Robert Collett and H. C. Woodbridge, regional supervisors, fuel conservation section, Eastern and Allegheny regions; and E. J. Pearson, federal manager.

The Theory of the Injector.

Nearly everyone knows that the steam injector was invented in 1858 by a French engineer named H. V. Gifford, but it was a long time after that any satisfactory statement of the cause was forthcoming as to the ability of steam to force water into the boiler from which the steam was originally drawn. In fact, as late as 1873, Dr. Henry Evers in his book, *Steam and the Steam Engine,* says: "This is a novel contrivance for feeding boilers, fast superseding all other of feed, but no convincing explanation of its action has been offered."

Later years have brought fuller knowledge. The cause is generally stated as the result of the high velocity of the steam, which is comparatively a light body, giving motion to the heavy body of water with which it commingles in the combining tube, and increasing the velocity of the water sufficiently to overcome the pressure of the steam in the boiler. Forny very beautifully illustrates this principle by taking as an example a light wooden, or a hollow ball, which readily floats on water, and shows no tendency to stay down, if plunged below the surface. Such a ball, if thrown on water, simply makes a splash, but does not sink. If, however, the ball be dropped from a height, it will go down a considerable distance in the water before its natural buoyancy will cause it to push itself up to the surface, where it will float. This example is intended to emphasize, when applied to the injector, the effect of the velocity of the water which has been forcibly urged on the action of the steam.

This explanation is apt enough, but there are other things which help toward the final result. One of these is that the steam coming in contact with the water at the nozzle of the steam tube condenses, and by the formation of a partial vacuum rapidly makes way for more steam to follow, and this condensation of steam tends to increase the velocity of the following steam, and so hasten it in imparting its motion to the water. It also heats the water and renders its entry into the boiler in the hot state, one of the economies which is justly claimed for the injector.

The tapering form of the combining tube augments the velocity of the whole, as is the case with any tapering nozzle where a given volume of water must pass through a small opening in the same time that an equal volume of water could flow through a larger orifice. The rapidly moving mass, heated and mixed in the combining tube, enters the delivery tube across a short opening leading to the overflow. The delivery tube is made so that its smaller end is the entrance end for the water flow, and in this the delivery tube is different from the forms of the steam nozzle or the combining tube. The object of this widening of the delivery tube as the water passes through it, may not be apparent at first sight, but by a well-known hydro-dynamic principle the moving water loses slightly in velocity, but gains in pressure, until it rises sufficiently to overcome the boiler steam pressure and enter.

Perhaps a reference to one of the many and instructive experiments made by Pascal, may help us to understand the principle of which we have just spoken. As long ago as 1647 this celebrated French geometrician, philosopher and writer, performed the experiment of bursting a keg filled with water by the addition of a small quantity of the same liquid. He fitted into the upper head of a strong cask a tube of small diameter and about 34 ft. long. The cask being filled with water, closely and securely made watertight, and able to stand a considerable internal pressure, had the tube of small diameter fitted tightly into it. When the long slender tube was only partly filled with water the cask gave way and burst from excessive internal pressure. This internal pressure was the same as if the slender tube had been of the same diameter as the cask, or even greater. The flow of water in at the small end of the delivery tube, encountering a constantly widening pathway, is in a way analogous to the slender tube and the cask, in Pascal's experiment in hydrodynamics.

There is, however, another action of the moving water under all the conditions we have endeavored to describe, which adds its quota to the general result. It is here that the matter of shock, or blow or impact comes in. The blow of the moving water which had its velocity increased by the formation of the partial vacuum at the end of the steam tube, and again lost some of its velocity while gaining pressure in its progress through the delivery tube, strikes the under side of the top check. The sudden impact of the water unseats the valve and gives passage to the fluid. The effect of the overflow had been made to act where the water left the combining tube and entered the delivery tube. This tube permits the water to flow to the atmosphere without encountering any opposing pressure, and the flow continues until sufficient velocity and pressure are generated in the delivery tube to unseat the top check and flow into the boiler, when we say the injector is "working." The shock of the water on the underside of the top check is like the light, yet efficacious, blow of a tack-hammer, which might disengage a detent, from which hung a heavy weight, though upon the weight, the light hammer blow would make no impression of itself alone.

It will thus be seen that the injector did not come in its present perfected state from the hands of the original inventor, but has been largely improved by many distinguished engineers, several of them being Americans.

Electrical Department

No-Voltage Control—Electric Railway Equipment—Control of Railway Equipment—What Is Meant by Bridging System ?

In our April issue we discussed the use of no-voltage control for electric railway equipments. We have had several inquiries asking for additional explanation on one or two points. In order that all may get the benefit we will explain them here.

In the case of electric operation using the third rail to carry the power to the electric trains, it is not possible to have a continuous third rail as is possible with an overhead conductor or trolley wire. Cross-overs, turn-outs, etc., make it necessady to break the third rail and "gaps" therefore exist. These gaps are in many cases longer than the cars, so that each car of the train as it passes through the gap loses the power. The loss of power may be of very short duration, or it may be as much as several seconds, depending on the speed of the train, and on the length of the gap.

A moment's thought will show one that it would be next to impossible for the motorman to throw "on" and "off" the master controller at the head end of a train, made up of, say, ten cars as operated in the New York subway, so that each car would be "off" as it passed through the gap and "on" immediately after. Some means is necessary to automatically deal with this situation, so that Fig. 1 is pulled up by the magnetic troller "on" in the full running position and pay no attention to the gaps, no matter at what speed the train may be running; knowing that each car will automatically take care of itself without damage to the equipment, and any jar will be imperceptible to the passengers.

When the train takes a cross-over or passes through a gap, the electric power is disconnected from the car due to the contact shoes leaving the third rail. The switches, used to connect the power to the motors, open and the car is in the "off" position although the motorman has not thrown off the controller. As soon as the current is again connected to the car, due to the third rail shoes making contact with the third rail, the switches come in again step by step in the same sequence as if the motorman had thrown off the controller and notched it up again. In other words, an automatic feature must be installed which will allow each car to function by itself, depending on whether it is in contact with the third rail or not, and thus prevent "surging" between cars in the same train.

To obtain this automatic functioning of the control apparatus, two small pieces of apparatus, termed relays, are used. One is the no-voltage relay and the other is the limit relay or limit switch, as it is sometimes called.

The no-voltage relay consists of a large number of turns of small wire wound on a spool. One end of the coil is brought to the lead connecting with the third rail shoes, and the other end is connected to the ground, so that whenever the third rail shoe is on the third rail, this coil is energized. There is a pull on the plunger and the disc (d) is held in contact with and connects together the two control wires shown in Fig. 1. The disc (d) is held in this position at all times when the shoes, or one shoe of the one car, is in contact with the third rail, providing that power is on the rail. The control wires, used to control the opera-

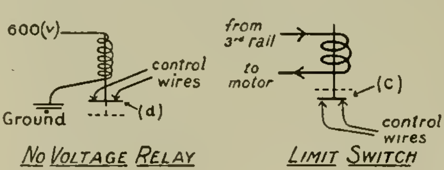


FIG. 1.

tion of the switches, are so arranged that the two control wires, running to the no-voltage relay must be connected together, in order that the switches may come in and power be connected to the motors. Even if the master controller at the head end of the train be in the full running position, the switches will be out, and no current will be flowing to the motors if the two control wires on the no-voltage relay are not connected. We have mentioned just above that these wires are connected when the coil is energized. It is perfectly clear, then, that as the shoes on any particular car leave the third rail at the gap there is no power, the coil is not energized and the switches fall out. Even if the switches stayed in, there would be no power to the motor, so the question arises, what benefit is gained by dropping them out, or having them opened? It is to get ready for the power again. If the train proceeded at a uniform rate through the gap, there is no particular benefit gained by having the switches drop out; but suppose the gap was long, as on a ladder track, and that the train slowed down, then it is very essential to have the switches drop out independent of the motorman, so that when the electric power is again connected to the car, there will not be a heavy rush of electric current due to the switches being all in while the car is operating at a slow speed, but the switches will come in step by step as if the train was starting up from a standstill. Another condition would exist where the train would be standing still with, say, the first 3 or 4 cars in contact with the third rail and the remaining cars in the gap. The switches on the dead cars should not begin to come in until the respective shoes of each car come in contact with the third rail, otherwise each car, if the switches were in, would jerk badly as the power was "picked up."

We have explained that it is necessary for the no-voltage relay to be energized and the disc (d) connecting together the two contacts, before the electrical switches can come in. This relay determines whether the switches are to be in or not, but does not have any control over the speed that the switches will come in at. Some provision is necessary so that the speed will not be too rapid, and the limit relay is therefore used. The limit relay is made up of a few turns of heavy copper strap, through which passes every bit of current taken by one motor. The plunger, to which is fastened the disc (c) Fig. 1, is pulled up by the magnetic pull in the few turns of the strap. The plunger is loaded, that is, weighted, so that a certain amount of current must pass through the coil before it will raise. Each switch is interlocked by the preceding one; that is, No. 2 switch can not come in until No. 1 has come in nor No. 3 before No. 2. Moreover, this progression of switches is controlled by the limit relay. As long as the disc (c) is in contact with the control wires the switches will continue to come in, but as soon as the plunger rises the progression of switches will stop, and will not commence again until the plunger has fallen down again. We have pointed out that the limit relay coil is energized by the current passing through one motor. The above statement means that as long as the motor current is above a certain value, the plunger is held up and no more current can pass to the motor until this value has been reduced.

Now, what reduces this current value to the motor? We know that as the car speeds up, the motor current will fall. Because there is a choking action in the motor itself, called the back electromotive force, and this back electro-motive force increases with the speed of the motor. It never reaches the value of the impressed voltage, because there is always

a flow of current going to the motor, not from it.

When the current falls to a certain value, depending on the weight of the plunger, the plunger will fall, as it is heavier than the magnetic pull. Contact is made on the control wires and another switch comes in, cutting out a step of resistance; more current flows to the motor and the plunger is held up until, with the increased speed of the car, the back electromotive force increases to a value where the current is choked back so that another switch can come in. This is repeated for each step of the resistance until the switches are all in.

From the above it should be clear that if the train was running at, say, 10 miles per hour when the current was permitted to flow, that the back electro-motive force would be considerably more than the voltage received at the motor, so that several steps of the switches would have to occur before sufficient increase of voltage would be obtained at the motor, to overcome the back electro-motive force by a sufficient amount to give current value enough to raise the relay and prevent further progression of switches. If the speed was 15 miles per hour more switches would have to come in before progression would be stopped; and if 20 miles an hour, all the switches could come in, as at that speed the back electro-motive force would be sufficient to prevent a flow of current of such a value as to raise the relay. The operation is automatic and "fool proof." The car adjusts itself to the conditions so that smooth operation is obtained through gaps, cross-overs, etc.

The operation amounts to this. The switches are all "out" while in a gap. The current finds its power reduced by the back electro-motive force, its own entrance produced. This force is always less than that from the third rail. As speed increases, more third-rail current enters, and a limit switch acts. The whole operation goes on again on a larger scale until limit switch No. 2 acts, and so on up to normal.

Control for Electric Railway Equipments—What Is Meant by the Bridging System.

We have all ridden in electric cars or trains, and have probably noticed that there is a wide variation in the operation as far as smoothness is concerned. In the case of the trolley car the smoothness of operation depends on the way the motorman handles the controller. If he uses due care and thought, fairly smooth operation can be obtained. If, however, he has no thought of the comfort to the passengers, very jerky operation will result from too rapid manipulation of the controller handle. The smoothness of the street car is entirely in the hands of the motorman, as there are no automatic features to regulate the maximum amount of current which can be taken by the motor, but will correspond to the rapidity of movement of the controller handle.

When we come to subway and elevated trains of the multiple unit system, automatic regulation is used. We have described how the automatic regulation is obtained in another article, namely, by using a no-voltage and limit relay. To many of us who have ridden on different systems of multiple-unit control, it has been noticed while some trains operate very smoothly throughout the entire range from start to, say, 20 miles per hour and so on up to full speed, other trains of a different and older type will show a very decided change in speed, resulting in a jerk at about 10 miles per hour. The trains will operate smoothly up to 10 miles an hour, there will then be a moment where the acceleration will not increase or, perhaps, fall slightly, and then the train will accelerate again smoothly to maximum speed. This slacking off or reduction in acceleration is at times very noticeable and of considerable discomfort to the passengers compared with the smooth operation throughout the entire acceleration period.

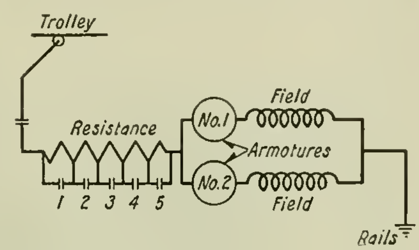


Fig. 2 A

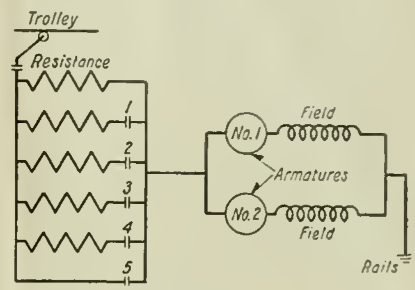


Fig. 2 B

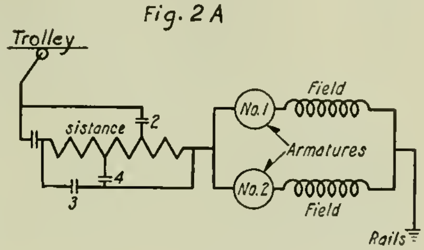


Fig. 2 C

Step	Switches 1	2	3	4
1	●			
2		●		
3		●	●	
4		●		●
5	●	●	●	

Fig. 2 D

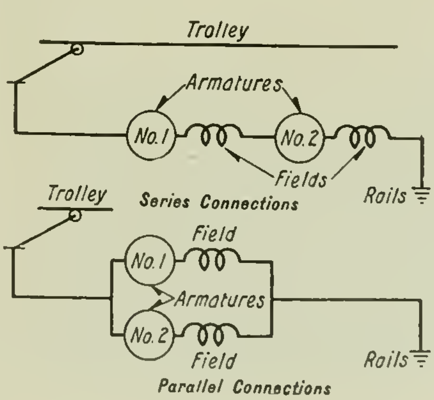


Fig. 3A

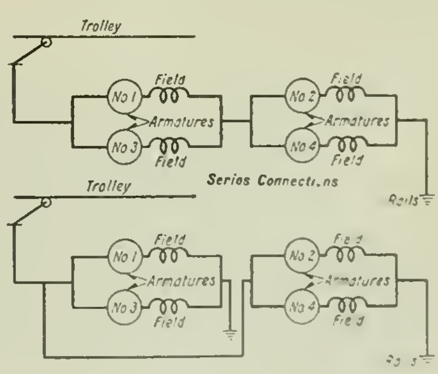


Fig. 3 B

We must now look for the reason of this variation. We have said that the operation is automatic, and that it is not the fault of the motorman. It therefore comes down to the method employed in changing the motor combinations so as to increase the speed. The latest modern equipments have the so-called bridging method while earlier equipments have the shunting method, and still earlier ones the open circuit method. To understand just what we mean by these terms it may be well to discuss the purpose of the control, how the motors are connected in combinations and what is accomplished.

The control apparatus on a car provides for the correct application of power in starting, and for the acceleration to full speed with the least energy expended and with uniformity of motion. It provides for operation "forward" or "backward," for opening the power circuits in order to slow down or stop, and for the protection of the equipment. If full trolley voltage were applied to the motors at standstill, an enormous current would flow through them and they would develop an immense tractive effort. The large current flow results as there is no speed of rotation, and hence no back

electro-motive force to choke back the current. The result would be disastrous both electrically and mechanically; in fact, no sort of satisfactory operation would be possible.

The control, therefore, includes electrical resistance, made up in the form of grids mounted in one or more frames, which are connected in series with the motors during the starting. This resistor is provided with taps so that the amount of resistance in the circuit may be gradually reduced from the maximum at the instant of starting until it is finally all cut out of circuit and the motors are receiving full voltage.

The various connections are made by the switches. The number of switches are limited so that the voltage is applied to the motors gradually by steps, instead of continuously, which would be the ideal method if it was practicable. Hence the current, and consequently the tractive effort of the motors, varies during the "notching-up" process.

There are three classes of resistor connections used in starting, namely, series resistors, parallel resistors, and combination resistors.

With "series resistors" all of the resistance is in circuit at first, and it is gradually short-circuited by sections as indicated by Fig. 2 (a). Switches for short-circuiting the sections are indicated at 1, 2, 3, 4 and 5. When power is first applied all of these switches are open. They are closed consecutively in notching up the controller until all are closed. In this position the motors are running on full voltage without resistance in the circuit,

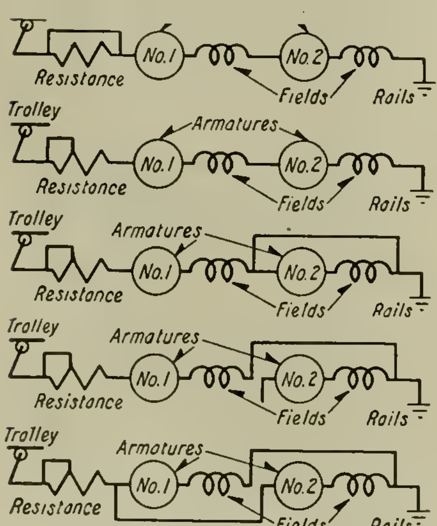


Fig. 4

and this is an economical operating condition.

With "parallel resistors" only a part of the resistor is in circuit at starting, and additional resistors are connected in parallel with the initial section by successive notches until finally the entire resistor is short-circuited. This arrangement is shown by Fig. (2b) where 1, 2, 3, 4 and 5 indicate switches which are all open at the start and are closed consecutively. When switch 5 is closed the equipment is in an economical running connection.

The "combination resistor" includes both "series" and "parallel" connections. Fig. 2 (c) shows this arrangement, and the sequence of operation of the switches is indicated by Fig. 2 (d). Step No. 5 is the

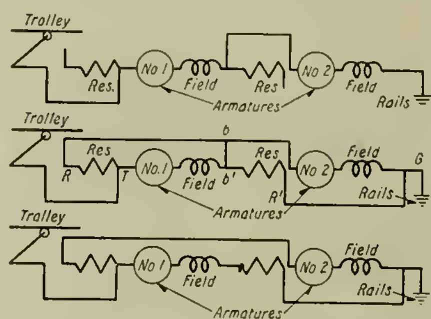


Fig 5

running position without resistance in circuit.

Equipments include an even number of motors. For the purpose of illustrating the resistor connections only, the motors in Fig. 2 (a, b, and c) were shown as two, connected permanently in parallel. This arrangement is hardly ever held to in practice. The motors are first connected in series either individually or in groups, and then changed into parallel. The purpose of this series parallel arrangement is to reduce the rheostatic loss. When two motors are in series each takes only half of the trolley voltage, and the loss in resistors is approximately one-half the amount it would be without the series parallel connection.

The series-parallel combinations for a two-motor and a four-motor equipment are shown by Fig. 3 (a) and 3 (b).

The changing from series to parallel combinations is known as the transition. It is during this period that there may be a change in acceleration causing the jerking to which we have referred, depending on the method used in making this transition. There are three methods in existence, namely, the open-circuit method, the shunting method, and the bridging method.

The order of these events is the order as developed and brought out and the order of efficiency. For instance, the bridging method is the latest developed and the smoothest in operation, while the open circuit method was the first and the roughest.

In the "open-circuit method" on the "transition" step the connection is broken between the motors and also between the trolley and motors so that there is no current flowing and the motors are developing no torque to propel the train. The speed falls, and when the power is again connected there is a rush of current, the motor suddenly imparts force to the car and there is a decided jerk. In this method the leads are "open circuited," hence the name.

With the shunting method shown in Fig. 4 there are three transition steps. On the first step part of the resistance is inserted in the circuit with the motors still in "series." On the second "transition" step, one of the motors is short-circuited or "shunted," which gives the name to this method. On the third transition step the "shunted" motor is disconnected from the other motor and from the shunt. On the second and third transition points, one motor is developing no torque, but the other is still working. Therefore, this method has an operating advantage as compared to the open-circuit method in that only one-half of the torque is dropped during the transition instead of all.

In the bridging method two resistors are used. To understand what happens refer to Fig. 5, which shows three positions, the last series the "bridging" and the first parallel. On the bridging step the motors in "series" are receiving full trolley voltage through the circuit T b^1 b G and the two resistors are in series with each other between trolley and rail, receiving the voltage through circuit T R b b^1 R^1 G. This circuit is parallel to the motor circuit. A bridging connection b b^1 is made between the junction points of the two resistors and the junction point of the two motors establishing the two parallel circuits, T b^1 R^1 G and T R b G, each comprising one motor and one resistor in series. On the first parallel notch b b^1 (the bridge) is opened and the motors are in "parallel" with the resistor in series with each other.

This method has an advantage over both of the other methods, in that both motors are working all the time and none of the torque is dropped during the transition period. Smooth operation is thus obtained.

The Scrap Heap

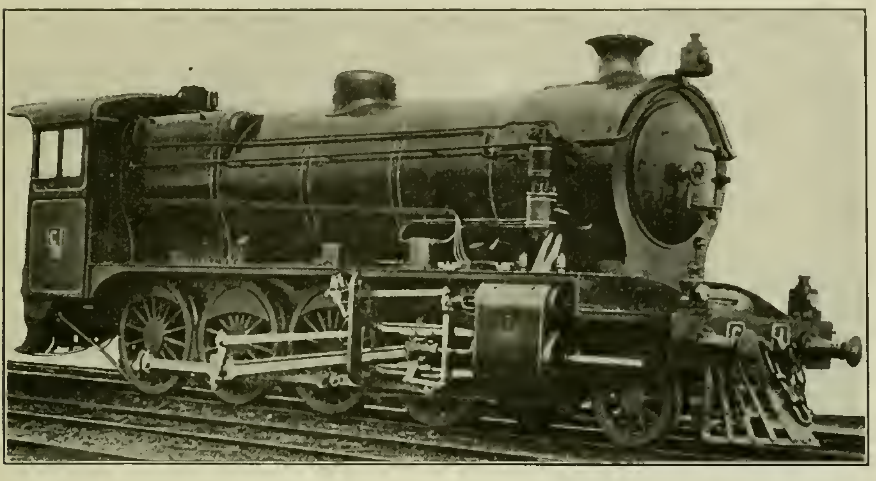
The scrap heap is a kind of a shop barometer telling in its own mute way of the general shop management, and of the use and misuse of materials. A scrap heap represents and spells "employed capital," and at this time when all railroad materials have advanced enormously in price the employment of this capital should be along business lines, so as to produce available assets.

Many valuable lessons can be learned by an intelligent inspection of various pieces which are common to a scrap heap. The undue weakness of component parts of locomotives, cars and machinery is shown by their presence on the scrap heap, and a careful inspection of the appearance of the breaks will show where the parts need strengthening.

Locomotive Construction in Australia

By C. F. DEWEY, Sydney, N. S. W.

In order to deal successfully with the constantly increasing freight traffic on the Victorian, Australian, Government system, and also to minimize the practice of double-heading which has had to be resorted to so much in the past, the Railway Commissioners have made provision for the introduction of a number of heavy locomotives of the 2-8-0 or Consolidation type.



2-8-0 TYPE PASSENGER LOCOMOTIVE FOR THE AUSTRALIAN GOVERNMENT.

The initial engine of this new class, No. 1 "C," which we illustrate, has recently been put into service and has been undergoing a series of test runs, all of which have up to the present rendered very satisfactory returns. For instance: one test train made up of 31 loaded coal trucks and 1 caboose, weighing 554 tons (exclusive of locomotive 128 tons) made a trip from Melbourne to Seymour a distance of 61 miles, in 21 minutes ahead of scheduled time which allowed three hours. This is considered to be exceptional working as this particular section has some very heavy grades, including a 1 in 50 extending for two miles, and furthermore, the coal used was of inferior quality.

In order to appreciate the size and capacity of this locomotive from an Australian point of view, perhaps one or two comparisons would not be amiss. The Victorian Railways "Dd" class 4-6-0 light lines mixed and freight locomotive with a tractive power of 20,000 lbs. is taken as standard and rated at 100 per cent. capacity; its load behind the tender over a grade of 1 in 50 is 270 tons. The "A2" class 4-6-0 fast passenger locomotive is rated at 130 per cent., has a tractive power of 25,000 lbs. and will haul a load of 350 tons up a similar grade. This new engine has a tractive effort of 37,000 lbs., is rated at 205 per cent. and will haul 555 tons behind the tender up a 1 in 50 incline, and 1,600 tons over flat or level track.

This locomotive was manufactured to the designs of W. M. Shannon Esq., Chief Mechanical Engineer of the Victorian System, at the Railway Workshops, Newport, Vic. Its construction incorporates all the most modern contrivances adaptable to local conditions. It is equipped with a boiler of large dimensions, a firebox and grate designed specially to suit the class of coal used, a Robinson superheater, Flaman speed recorder, Detroit 5-feed lubricator, reflex gauge glasses and a Victorian Railways standard injector of Newport make. The magnesia boiler covering is also of Newport make. Walschaerts valve gearing of simple and exceedingly compact design has been adopted. All the steel and iron castings, including wheel centres and cylinders, are of Australian manufacture. Other improvements worthy of note are the operation by compressed air of the ash pan door slides, and the emptying and cleaning of the smoke box by a jet of hot water from the boiler.

The locomotive presents a handsome appearance and is the largest and most powerful in Australia. It eclipses in some respects any locomotive on Great Brittain's railways, superseding in power and weight both the "Great Bear" and the "Sir Sam Fay." It may therefore be considered as a monster of Australian locomotive construction.

The leading particulars of the locomotive are as follows: Diameter of drivers, 60 ins.; cylinders, 22 ins. x 28 ins. stroke; boiler pressure, 200 lbs. per sq. in.; grate area, 32 sq. ft.; heating surface: firebox, 173 sq. ft.; tubes, 1,879 sq. ft.; superheater, 369 sq. ft.; total, 2,421 sq. ft.

Tender capacity—Water, 4,600 gals.; fuel, 6½ tons; total length, engine and tender, 64 ft. 4½ ins.; total weight, 127 tons; gauge, 5 ft. 3 ins.

The older type of a A2 class 4-6-0 fast passenger locomotive is of the following general dimensions: Driving wheels, 72 ins. diameter; heating surface, 2,215 sq. ft.; grate area, 29 sq. ft.; boiler pressure, 185 lbs. per sq. in.; cylinders, 22 ins. by 26 ins. stroke; tractive effort, 25,867 lbs.; weight—engine and tender, 118 tons; total length over all, 62 ft. 6⅞ ins.

4-6-0 TYPE PASSENGER LOCOMOTIVE FOR THE AUSTRALIAN GOVERNMENT.

Hardening Copper and Bronze.

The hardest cupro-tin alloy is composed of 73 per cent. copper and 27 per cent. tin, and where this is obtained on a copper soldering bolt which has been "burnt," it takes a good file and much labor to remove the hard metal. By purposely adopting the same method of surface alloying, a similar hardness can be secured, and the surface of copper and bronze made practically proof against filing. The copper or tin alloy is kept at a full red heat under a coating of tin for some time, the surface forming an alloy of the maximum hardness, although care is necessary not to overdo the matter. It is stated on good authority that this is one of the oldest methods of hardening the surface of the softer metals, and was used by the ancients in hardening the edges of some of their weapons used in battle.

Items of Personal Interest

Mr. J. Brooks has been appointed assistant master car builder of the Grand Trunk, with office at London, Ont.

Mr. W. A. Pitt has been appointed assistant master car builder at the Montreal, Que., shops of the Grand Trunk.

Mr. W. F. Paulus has been appointed steel car foreman of the Erie, at Kent, Ohio, succeeding Mr. I. M. Lower, transferred.

Mr. E. J. Frazer has been appointed general road foreman of engines of the Southern, lines west, and the Alabama & Vicksburg.

Mr. J. Beckwith, general manager of the Florida East Coast, with office at St. Augustine, Fla., has been appointed federal manager.

Mr. G. E. Lund has been appointed general foreman of the Erie, with office at Hammond, Ind., succeeding Mr. C. Roth, transferred.

Mr. C. B. Smith has been appointed general foreman of the Philadelphia division of the Baltimore & Ohio, with office at Philadelphia, Pa.

Mr. W. D. Duke, general manager of the Richmond, Fredericksburg & Potomac, with office at Richmond, Va., has been appointed federal manager.

Mr. W. A. Black has been appointed locomotive foreman of the Canadian Pacific, at Farnham, Que., succeeding Mr. W. D. Watson, transferred.

Mr. G. A. Hammond, general mechanical superintendent of the New York, New Haven & Hartford, with headquarters at New Haven, Conn., has resigned.

Mr. G. J. Wentz has been appointed master mechanic of the Montana, Wyoming & Southern, with office at Valley, Mont., succeeding Mr. H. R. French, resigned.

Mr. J. E. O'Brien, mechanical superintendent of the Missouri-Pacific, with headquarters at St. Louis, Mo., has had his jurisdiction extended over the Memphis, Dallas & Gulf.

Mr. A. Kearney has been appointed superintendent of motive power of the Norfolk & Western, with headquarters at Roanoke, Va., succeeding Mr. W. H. Lewis, retired.

Mr. M. C. Thompson, formerly road foreman of engines on the Pittsburgh division of the Baltimore & Ohio, has been appointed superintendent locomotive operations.

Mr. Ralston Tuck has been appointed general foreman of the Santa Fe shops at Needles, Cal., succeeding Mr. C. B. Perry, transferred to San Francisco, as general foreman.

Mr. L. N. Clark has been appointed master car builder on the Ontario lines of the Grand Trunk, with headquarters at London, Ont., succeeding Mr. T. A. Tredeaven, retired.

Mr. C. H. Funk, chief smoke inspector, has been appointed also supervisor of locomotive operation of the Cincinnati Terminal under the United States Railroad Administration.

Mr. Garland P. Robinson has resigned as assistant chief inspector of locomotive boilers for the Interstate Commerce Commission to accept service with the American Locomotive Company.

Mr. G. L. Peek, federal manager of the Pennsylvania Lines West of Pittsburgh, with headquarters at Pittsburgh, Pa., has had his jurisdiction extended to include the Chicago Union Station.

Mr. F. H. Greenwood, superintendent of shops of the Norfolk & Western at East Roanoke, Va., has had his jurisdiction extended to include all departments of the East Roanoke shops.

Mr. R. E. Bell, division master mechanic of the Gulf, Colorado & Santa Fe, has been appointed joint master mechanic of the Galveston Terminal Association, with office at Galveston, Tex.

Mr. C. D. Young, superintendent of motive power of the Pennsylvania, with office at Wilmington, Del., has been commissioned as lieutenant-colonel in the Transportation Corps, Engineers.

Mr. W. A. Linn, purchasing agent of the Chicago, Milwaukee & St. Paul, with headquarters at Chicago, has had his jurisdiction extended over the Escanaba & Lake Superior and the Ontonagon.

Mr. J. E. Gorman, federal manager of the Rock Island Lines, with headquarters at Chicago, has had his jurisdiction extended over the Des Moines Union, the Des Moines Western and the Iowa Transfer.

Mr. W. L. Robinson has been appointed supervisor of fuel consumption on the Baltimore & Ohio western lines, the Dayton & Union, and the Dayton Union railroad, with headquarters at Cincinnati, Ohio.

Mr. Charles Emerson has been appointed master mechanic of the Fargo division of the northern division of the Northern Pacific, with offices at Dilworth, Minn., succeeding Mr. R. P. Blake transferred.

Mr. Silas Zwight, general master mechanic, and Mr. W. J. Bohan, mechanical engineer of the Northern Pacific, have been appointed assistant mechanical superintendents, both with headquarters at St. Paul, Minn.

Mr. U. B. Earling, general manager of the Chicago, Milwaukee & St. Paul, lines west of Mobridge, S. D., with headquarters at Seattle, Wash., has had his jurisdiction extended over the Port Townsend & Puget Sound.

Mr. O. A. Garber has been appointed master mechanic of the Minnesota and Iowa divisions of the Illinois Central, with headquarters at Waterloo, Iowa, succeeding Mr. Norman Bell, resigned to enter military service.

Mr. J. E. Angling has been appointed inspector of locomotive service on the Erie lines east of Salamanca, N. Y., with headquarters at 30 Church Street, New York, succeeding Mr. V. C. Randolph, on leave of absence.

Mr. J. J. Barry has been appointed general master mechanic of the Norfolk & Western, with offices at Roanoke, Va., and has jurisdiction over all shops and motive power department employees other than at East Roanoke shops.

Mr. J. F. Kimbell, formerly division foreman of the El Paso & Southwestern, at Carozozo, N. M., has been appointed master mechanic of the Western division, with headquarters at Douglas, Ariz., succeeding Mr. F. P. Roesch, resigned.

Mr. C. Wittel has been appointed day roundhouse foreman of the Rock Island at Herington, Kans., succeeding Mr. W. J. Devitt, transferred, and Mr. W. S. Addington has been appointed night roundhouse foreman at Haleyville, Okla.

Mr. Charles P. Richardson, assistant engineer of track elevation of the Chicago, Rock Island & Pacific, has been appointed engineer of water service of the Rock Island lines, with headquarters at Chicago, succeeding Mr. J. M. Brown.

Mr. T. A. Foque, general mechanical superintendent of the Minneapolis, St. Paul & Sault Ste. Marie, has had his jurisdiction extended over the Duluth, South Shore & Atlantic, and the Mineral Range, with headquarters at Minneapolis, Minn.

Mr. G. W. Cundiff has been appointed road foreman of engines of the Mobile & Ohio and the Southern in Mississippi, with office at Jackson, Tenn., succeeding Mr. A. J. Merriweather, appointed fuel supervisor, with office also at Jackson, Tenn.

Mr. L. H. Turner has been appointed superintendent of motive power of the Pittsburgh & West Virginia, and the west side Belt, with headquarters at Pittsburgh, Pa., and Mr. H. F. Grewe has been appointed master mechanic, with office at Rock, Pa.

Mr. B. J. Farr, formerly master mechanic of the Grand Trunk, Western lines, at Battle Creek, Mich., has been appointed

superintendent of motive power and car department of the Western lines, with headquarters at Detroit, Mich., succeeding Mr. W. H. Sample.

Mr. D. C. Wilson, formerly electrical engineer of the Union Pacific, has been appointed electrical engineer of the Central of Georgia, with headquarters at Savannah, Ga., and Mr. H. B. Gamer has been appointed acting electrical engineer, succeeding Mr. Wilson.

Mr. W. H. Sample, formerly superintendent of motive power of the Grand Trunk, Western lines, at Detroit, Mich., has been appointed general superintendent of motive power and car department of the Grand Trunk system, with headquarters at Montreal, Que.

Mr. Maynard Robinson, division master mechanic of the Gulf, Colorado & Santa Fe, with office at Temple, Tex., has had his jurisdiction extended to include the Galveston division. This division has been combined with the Southern division, and will be known as the Southern division.

Mr. Lawrence B. Thompson, and Mr. A. Roy Wood have been appointed road foremen of engines on the Southern, with offices at Spencer, N. C., and Mr. J. S. Lawrence, assistant road foreman of engines, at Spencer, and Mr. A. Overton to a similar position at Knoxville, Tenn.

Mr. C. R. Burns has been appointed road foreman of engines on the Pittsburgh division of the Baltimore & Ohio, with office at Glensmore, Pa., and Mr. J. C. McAvoy has been appointed road foreman of engines, with office at Foxburg, Pa., succeeding Mr. D. B. Fawcett, transferred.

Mr. H. C. Oviatt, formerly superintendent at Danbury, Conn., has been appointed superintendent of motive power of the New York, New Haven & Hartford, the Central New England, the New York Connecting, the Wood River Branch, the Union Freight railroad and the Narragansett Pier railroad, with headquarters at New Haven, Conn.

Lt. Colonel Reuben W. Leonard has been elected president of the Engineering Institute of Canada. He served in the Northwest Rebellion, and afterward served for many years in construction work on the Canadian Pacific, and latterly as chief engineer on several of the Canadian railways, and constructor of hydro-electric power plants. He was also chief commissioner of the National Transcontinental Railway.

Mr. J. E. Murray, formerly electrician of the Chicago & North Western, with headquarters at Chicago, has been appointed electrical and mechanical engineer of the Grand Trunk Western lines, with headquarters at Battle Creek, Mich, and Mr. J. A. Peters, formerly foreman of the electrical department of the Chicago & North Western shops, at Chicago, has been appointed chief electrician of the entire system, succeeding Mr. Murray.

Mr. Daniel Willard, president of the Baltimore & Ohio, has been selected by General Pershing, at the request of the French Government, which desires the services of an American railroad operating officer as an assistant to the French Transport Department. As stated in our pages last month the French Government has decided to take over the control of the French railways. Mr. Willard has been appointed colonel of engineers. He has been granted indefinite leave of absence, and Mr. L. F. Loree, a member of the executive committee, will act as chairman of the committee during Colonel Willard's absence.

Hon. William G. McAdoo, Director General of Railroads and Secretary of the Treasury, resigned from these and other positions on November 22. He has served as head of the Railroads nearly one year and nearly six years as Secretary of the Treasury. He will retire from the railroad administration on or before January 1, 1919, and will leave the treasury department as soon as his successor is appointed. Mr. McAdoo states that he has been overworked and underpaid and proposes resting for a few months, after which he will likely resume law practice in New York City. The President expresses his regret in parting with one who has rendered admirable service.

WILLIAM G. McADOO
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Westinghouse Air Brake Company.

The issue of the annual report of the Westinghouse Air Brake Company has been postponed until March, next year. There is no anticipation of a reduction of business next year, for the reason that the brake equipments and draft-gear now being supplied for application to the cars and locomotives ordered by the United States Railroad Administration include a relatively small number originally intended for use on American lines in France, but the demand in this country is so great that the entire number of equipments on order will be required as promptly as they can be provided. The same statement applies to the Union Signal Company, and the company's other subsidiary and associated companies, and the net earnings for the year 1918 when published will show earnings much beyond any previously reported for a similar period.

Railway Electrical Engineers

At the annual convention of Railway Electrical Engineers held at the La Salle Hotel, in Chicago, this year, the following officers were elected for the ensuing year: President, J. E. Gardner, Chicago, Burlington & Quincy R. R.; senior vice-president, L. S. Billau, Baltimore & Ohio R. R.; junior vice-president, L. C. Hensel, St. Louis-San Francisco Ry.; and as members of the executive committee, E. Wanamaker, formerly of the Chicago, Rock Island & Pacific Ry.; E. S. M. McNab, Canadian Pacific Ry.; A. E. Voight, Atchison Topeka & Santa Fe Ry.; C. H. Quinn, Norfolk & Western Ry.; E. Lunn, Pullman Co., and F. J. Hill, Michigan Central R. R. Jos. A. Andrucetti, Chicago & North Western Ry., Chicago, continues as secretary and treasurer of the organization.

Manufacturers of Chilled Car Wheels

At the recent annual meeting of the above mentioned association held at the Waldorf-Astoria, New York, the following were elected officers for the ensing year: President and treasurer, George W. Lyndon; vice-presidents, E. F. Carry, president, Haskell & Barker Car Company, and J. A. Kilpatrick, president, Albany Car Wheel Company; secretary, George F. Griffin, president, Griffin Wheel Company; consulting engineer, F. K. Vial, chief engineer, Griffin Wheel Company.

N. Y. Railroad Club.

Not long ago Mr. Chas. E. Fowler read a paper before the members of the New York Railroad Club on the "Architecture and Construction of Bridges." The meeting marked the opening of the fall season of 1918, and was well attended. Among other things, Mr. Fowler said: The architecture and construction of bridges has undergone an evolution from the earliest times, and the stone beams of the Egyptians may be regarded as the first girders ever employed, unless it might be considered that the unconscious use of fallen logs across small streams to effect a passage antedated the studied use of stone slabs for crossing streams.

The first use of the arch with voussoirs was undoubtedly by the Babylonians, as some of the ruins disclose arches of mud

bricks which were constructed about 4000 B. C.; and the arch was developed in Roman times into structures of real architecture, such as the bridge of Augustus at Rimini. The earliest type of the suspension bridge was undoubtedly the swinging vine.

The suspension bridge went through a very interesting period of its evolution in Europe during the first half of the nineteenth century, and the chain bridge of Telford over the Menai Straits in Wales, with its 580-ft. span, is still in use, and is undoubtedly the prototype of many great suspension bridges yet to be constructed. The wire cable suspension bridge built over the Niagara gorge by John A. Roebling to carry railway trains was one of the earliest successful bridges of this form of construction in the United States, and while we revere the name of Roebling, it is with some amusement that we read in his report of the tests on its completion of a 23-ton engine being used for this purpose, and of one very heavy locomotive of 36 tons being run over the bridge.

The earliest examples of modern long span girder bridges were the iron tubular girders of Robert Stephenson, one a single span of 406 ft. at Conway Castle, England, and another the double tube continuous girder bridge at the Menai Straits, with two spans of 230 ft. and two middle spans of 460 ft. each. The two most remarkable early long span open web girders or trusses in this country were the Louisville 400-ft. Warren truss by Fink, and the 519-ft. Whipple truss at Cincinnati by Jacob Luiville, built in 1876. The most recently built long bridge, with simple span, and the longest ever built, is the 721-ft. truss of the Metropolis bridge over the Ohio river.

The longest cantilever span is that of 1,800 ft. employed for the Quebec bridge, while the greatest bridge of the type in existence is the Forth bridge in Scotland with two spans of 1,710 ft. The longest spans of the cantilever form seriously proposed are for a bridge with three 2,000-ft. spans at San Francisco.

Theoretical considerations in the design of long span bridges are usually of secondary consequence, and in preliminary investigations need only be taken into account as factors of minor importance. The situation of a long span bridge and the length of span or spans are in the great majority of cases determined from practical considerations, and only the maximum, or perhaps the economical, span-length that is possible need concern the engineer. Sir Benjamin Baker stated in 1882, in an address on the Firth of Forth bridge: "It is not the physical features of the country, but the habits of the population that renders the construction of a 1,700-ft. span (bridge) expedient." The decision of the elder Roebling to design a 1,595-ft. suspension-span across the East River at New York may be ascribed to much the same reason, although in both cases the length of spans was finally determined from the proper and possible positions for piers and the considerations of ocean commerce. The site of the Quebec bridge was determined because of the desire of the people for a direct route of travel, and the span-length was determined from the most practicable location for piers.

The Roebling or first Brooklyn bridge is a striking example of the reason why 40 years of life has been assumed for long span bridges. The cables have enough strength to carry a new deck and present day traffic. Although the expansion rollers on the tops of the stone towers are "frozen," these towers have, by their elasticity and by the yielding of the foundations, carried the loads and can carry still heavier ones. On the other hand, the deck and the stiffening trusses, because of exigencies of finance and politics, were built so light as to require replacement years ago.

The length of span or spans is to a large extent determined by the position of foundations that are practicable. This was true for the Quebec bridge and also the Firth of Forth bridge, where the piers were built at the only practicable positions, the island of Inch Garvie and at the Fife and Queensferry shores. Because of Government requirements the only pier positions for bridges at New York across the East River were inside the pierhead lines. The only positions possible for piers for a bridge across the Hudson River are inside the pierhead lines in order to comply with similar Government requirements, also a pier near the center of the river is impossible on account of the great depth to bedrock. The pier positions for a bridge across San Francisco bay at Goat island must be fixed to comply with Government requirements for facilitating commerce.

The design of a great bridge is often thrown open to competition, which makes it necessary for the engineer to produce a plan for the least expensive structure, usually requiring the least possible weight. This is accomplished by using high unit stresses for a steel of the highest practicable strength, and usually produces a structure of too great elasticity. On the other hand, a bridge designed without competition and to have as great rigidity as is consistent with good engineering and good financiering, is a considerably heavier and more costly structure.

The economical proportions of individual structures of whatever type is a matter distinct from the economics proper, and for arch bridges deductions have been made by the writer in a discussion of the 100 longest arch bridges ever designed or built, and which will be published in an early number of the Transactions of the American Society of Civil Engineers.

Railroad Equipment Notes

A one-story 85x212-foot erecting shop will be constructed at Chambersburg, Pa., by the Cumberland Valley.

The United States Railroad Administration has put out an inquiry for 2,000 fifty-ton steel hopper cars for the Virginia Railway.

The Erie Railroad has taken out a permit to build a shop addition at its locomotive shops on Pavonia avenue at Jersey City, N. J.

The Kanotex Refining Company, Arkansas City, Kan., has ordered 50 40-ton tank cars from the American Car & Foundry Company.

The Pere Marquette is building a 16-stall roundhouse, a 90-foot turntable and a machine shop at an estimated cost of $160,000 at New Buffalo, Mich.

The New York, New Haven & Hartford has had plans prepared for a one-story forge shop and mill 40 x 80 feet at 132d street and Harlem river, New York.

The Washington Railroad & Navigation Company is contemplating the erection of a plate shop at Portland, Ore. It is estimated the building will cost about $67,000.

The Raritan River has awarded contract to the Austin Company, Philadelphia, for a one-story engine house at its local yards at South Amboy, N. J., to cost $200,000.

The Cumberland Valley has awarded contract to the Price Construction Company, Baltimore, for new car and locomotive shops at Cumbo, near Martinsburg, Va., to cost about $100,000.

Chicago, Milwaukee & St. Paul has been authorized by the railroad administration to build 5,000 freight cars in its own shops. They will probably be turned out at the rate of 1,000 a year.

The Union Pacific is planning for the construction of a new one-story machine shop at Eighth and Cass streets in Omaha to cost about $200,000. It will be used for assembling and erecting work.

The Chicago & North Western has awarded a contract to L. O. Peppard, 1712 Irving avenue, Minneapolis, Minn., for building an addition to the round house and several small buildings at Ashland, Wis.

In connection with its proposed new shop buildings and yard extensions at Grafton, W. Va., the Baltimore & Ohio is planning the construction of a machine shop, wheel pressing works, engine house and other structures.

The railroad shops and buildings now being constructed by the Pennsylvania at its South Philadelphia yards, near Greenwich Point, are estimated to cost, with equipment, about $1,000,000. Six buildings will be erected for general capacity increase.

The Itasca roundhouse and machine shop of the Chicago, St. Paul, Minneapolis & Omaha in the East End, Superior, Wis., were badly damaged by fire recently. They will be rebuilt at once, the contract having been let to Peppard & Fulton, Minneapolis and Duluth, Minn.

The three principal locomotive builders during the month of October, shipped 265 locomotives to railroads under federal control, in addition to 343 locomotives completed or shipped for miscellaneous domestic service or for use abroad, a total of 608. The 269 locomotives included 158 of the U. S. R. A. standard types.

The Baltimore & Ohio and the Western Maryland, Baltimore, Md., have awarded contracts to the Price Construction Company for the construction of new railroad shops, for construction and repair work, at Connellsville, Pa. The shops for the former are estimated to cost with equipment about $250,000, and for the Western Maryland, $100,000.

Additional large orders for portable track for military use in France have been placed through the French commission, it is said, representing a practical doubling of orders recently placed with a northern Ohio manufacturer and with a large export company, and they now total approximately 60,000 tons, including the rails, ties, fastenings, etc.

The new railroad shops to be erected at Hagerstown, Md., by the Western Maryland will consist of one-story buildings, including machine shop, foundry, wheel works, etc., to cost about $500,000. The Price Construction Company, Baltimore, is the contractor. The same contractor has also been authorized to build similar shops for the company at Elkins, W. Va., to cost about $500,000.

The United States Railroad Administration has ordered 600 locomotives in addition to the 1,415 which have already been ordered. It is expected that 400 of these will be built by the American Locomotive Company and 200 by Lima Co. Orders are distributed as follows: American Locomotive Company 150 eight-wheel switchers, 50 six-wheel switchers, 150 light Mikados, 50 heavy Mikados. The Lima Loco Co. build the rest.

Books, Bulletins, Catalogues, Etc.

Saving Coal in Locomotives.

The Engineering Experiment Station of the University of Illinois has issued a circular, the title of which is "The Economical Use of Coal on Railway Locomotives," that presents suggestions concerning ways in which saving may be made. It is stated that the saving of a piece of coal the size of an ordinary egg on each scoopful of coal used in locomotives would amount to 1,500,000 tons a year. Even when firing a freight locomotive on a heavy grade, one less scoopful of coal every fifteen minutes, or one less scoopful every three or four miles, would effect a similar saving. A little more personal interest on the part of railway officials and employes will reduce coal consumption even on railroads where the practice is already excellent and where an earnest effort is being expended to save coal. Copies of this circular may be had on application. Price 20 cents.

Southern Development.

S. Davies Warfield's address before the Southern Settlement and Development Organization has been published in pamphlet form. Mr. Warfield is strongly in favor of private ownership. He asks: "What will become of the individual incentive for invention which has produced the air brake and the other life saving devices and instruments for economy under individually operated railroads, now stopped, and one or two men sitting in their offices in Washington deciding on standards for all the railroads. The gradual encroachment of such a system upon property rights and upon personal liberty, the restraint entailed thereby, and the political control thus made possible, must finally result in a one-party country, the forerunner of a form of governmental autocracy that could be finally overthrown only by revolution."

Notes on Lignite.

The Bureau of Mines has issued a circular containing Notes on Lignite by S. M. Darling, from which it appears that lignite will never be used to any great extent in its raw state. The 30 per cent. of water which it contains prevents its use except in the vicinity of the mines. Millions of tons are used annually in the lignite-bearing regions, resulting in high prices for both industrial and domestic fuel, imposing a handicap on the industrial development of these regions. The dried lignite briquets, for large hand-fired industrial furnaces have proved them to be equal to good Middle West bituminous coal, and in the powdered form it is equally serviceable in locomotives.

Train Lighting Batteries

The Edison Storage Battery Company, Orange, N. J., has issued Bulletin 118, showing that electric vehicles equipped with Edison batteries have proved to be the most economical method for the solution of hauling and delivery problems everywhere. The fact that more than one hundred railroads use the Edison Alkaline Storage Battery for train lighting or signaling or both, leaves no room to longer question its value. Full particular are furnished in the finely illustrated Bulletin, copies of which may be had on application.

Dixon's Graphite

As we have repeatedly stated Dixon's Graphite Air Brake Grease is especially designed for lubricating parts of air brakes. It prevents all undesired quick action of air brakes due to imperfect lubrication and guarantees smooth operation of all parts. Copy of *"Graphite"* the company's monthly publication, can be had on application to the Joseph Dixon Crucible Company, Jersey City, N. J.

Softening Temperature

The Fusibility of Coal Ash and the Determination of the Softening Temperature, is the title of an interesting publication issued at the Government Printing Office, Washington, D. C., and copies may be had, price 20 cents. It is the combined product of A. C. Fieldner, A. E. Hall and A. L. Field, and is the result of much combined and individual research.

Coal Prospects.

Mr. Stefanson, the explorer, publishes a report that he has explored several new islands in the Arctic regions and mapped this new land, where, he states, they found coal on nearly every island they touched at. These coal lands may some day be of great value, for it was only a few years ago that the Spitzbergen Islands, in the Arctic north of the Atlantic were little thought of as coal producers. Now the Spitzbergen Islands are farther north than many islands on which coal has been found to rival that of Wales in England.

Wood and Peat in Denmark.

From a government report received from Denmark it appears that the shortage of coal during the last two years necessitated the carbonization of wood and peat—the latter after a certain degree of drying in stacks. Peat charcoal was less satisfactory, as much of it was small and had to be employed as an indifferent domestic and industrial fuel.